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ON ATKINSON'S GAS ENGINE.

[*Report of the Committee on Science and the Arts.*]

[No. 1432.] HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, April 1, 1889.

The Sub-Committee of the Committee on Science and the Arts, constituted by the FRANKLIN INSTITUTE of the State of Pennsylvania, to whom was referred, for examination,

ATKINSON'S GAS ENGINE,

Report that: They have examined the said invention and the description and drawings thereof, as shown in letters-patent of Great Britain, No. 3,522, dated March 12, 1886 (*Fig. 1*), and find it to consist of a combination of crank, link and lever movements, with a single acting piston reciprocating in a cylinder, so that two strokes of the piston take place for each rotation of

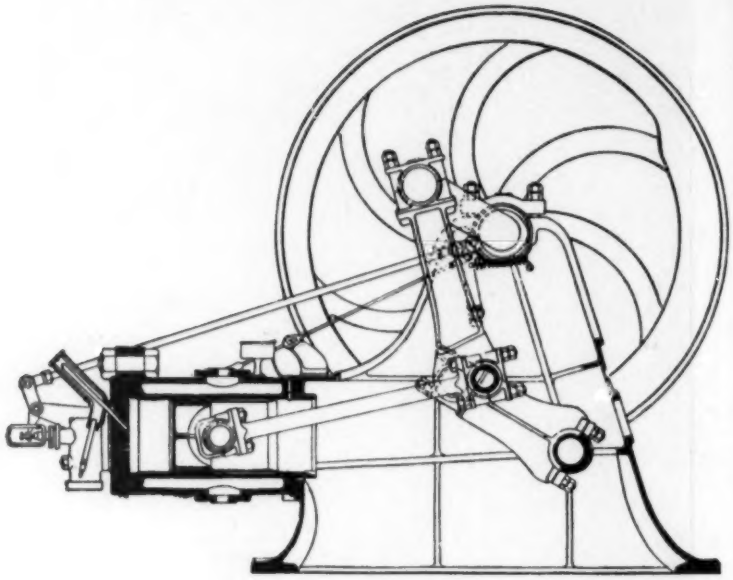

Fig. 1.—Atkinson's Gas Engine, 1886.

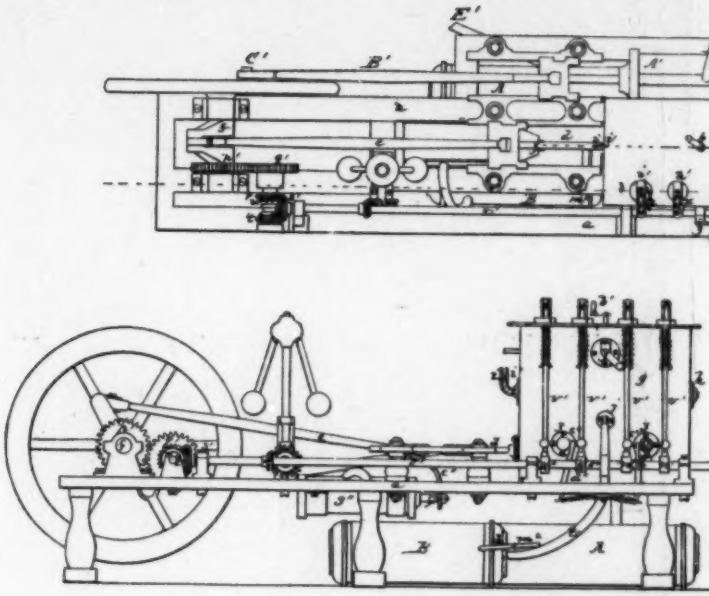

Fig. 7.—

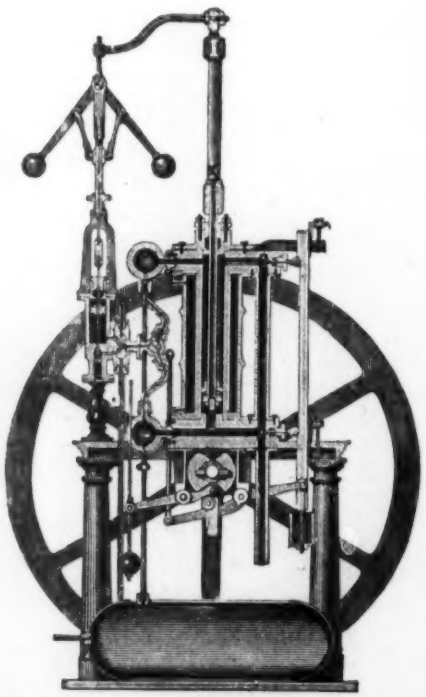

Fig. 3.—Wright's Gas-Exploding Engine, 1833.

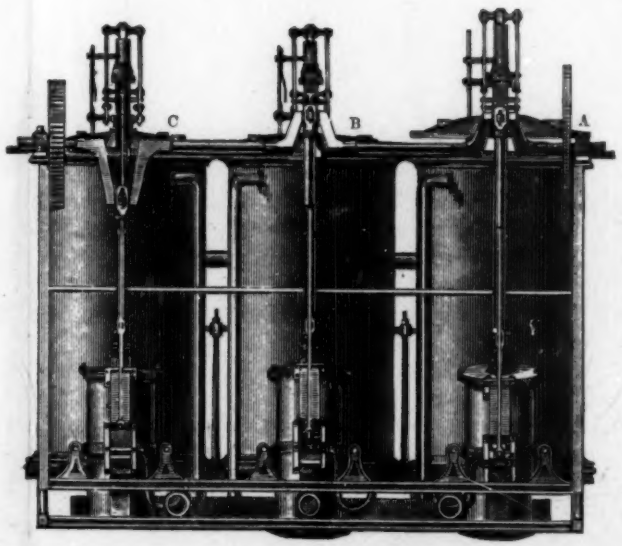

Fig. 2.—Brown's Vacuum Gas Engine, 1826.

Fig. 4.—

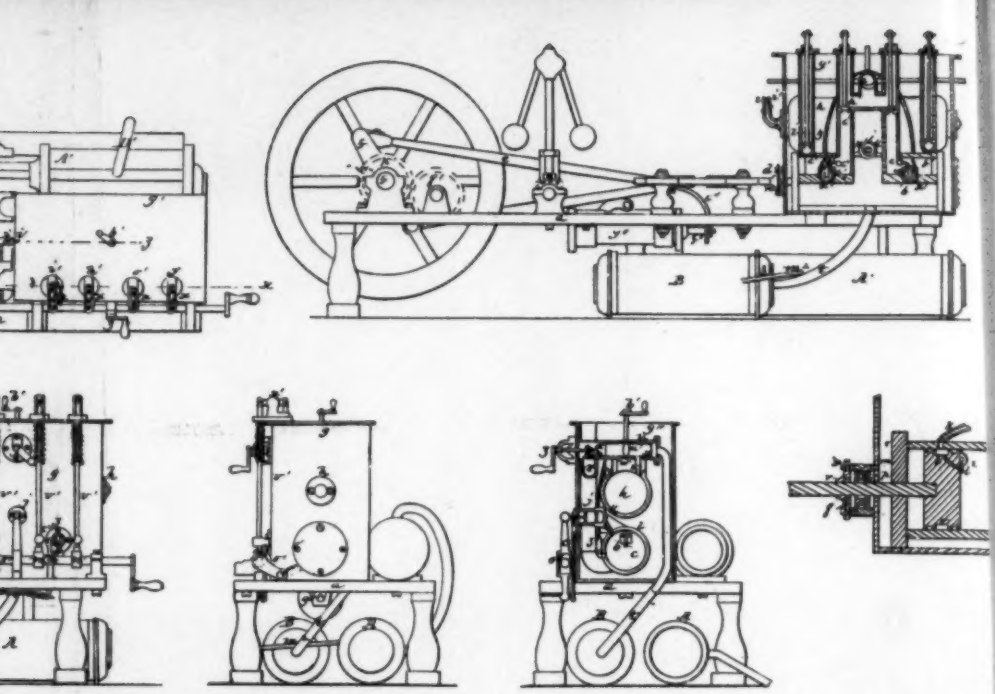

Fig. 7.—Perry's Gas Engine, 1846.

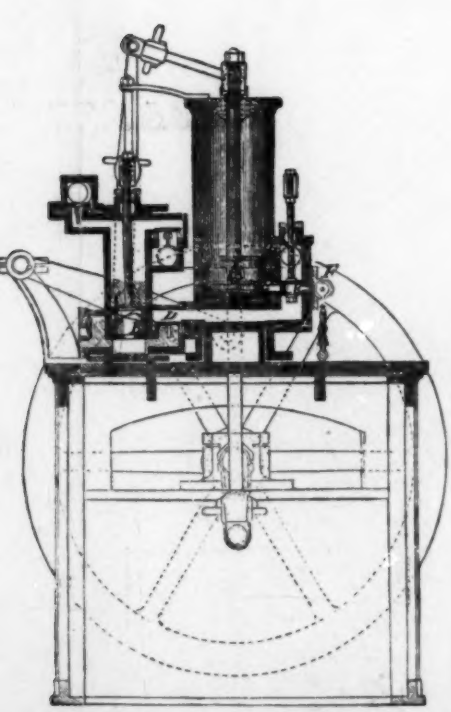

Fig. 4.—Barnett's Gas Engine, 1838.

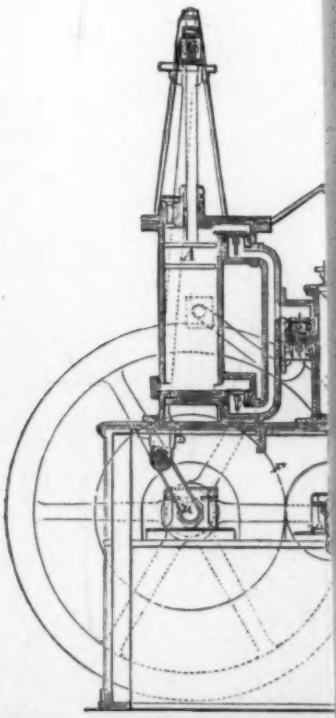

Fig. 5.—Barnett, 1838.

the crank, one stroke making an entire displacement of the whole cylinder capacity, and the other stroke leaving a space between the piston and back-head of the cylinder. Into this space a mixture of air and gas is drawn and enclosed, next compressed, and then ignited or exploded, propelling the piston in the cylinder, and imparting motion by a link to a lever, connecting rod and crank. The piston then acquires from the crank, through the lever and link, a returning motion of the entire length of the cylinder, and expels the products of the combustion of the former charge; next the piston moves toward the front end of the cylinder, receiving a charge of air and gas equal to about half the capacity of the cylinder; and the piston then returning part way, compresses such charge of air and gas in the cylinder ready for ignition in the same manner as the former charge.

An engine, rated by the manufacturer at six horse-power, has been twice tested by your committee, and the results of these tests, which are tabulated and appended to this report, show such an economical performance as to impress them with the importance of the machine as a competitor with the steam engine as a generator of motive power, and to entitle it, upon its merits, to a full and careful examination.

In order that the operation and special features of construction of this engine may be readily understood, the committee deem it expedient to give a brief general account of the mode of operation of gas engines and of the preceding state of art in this field of invention.

The first attempt or suggestion of an engine operated by gas is the proposition of Huyghens, in 1680, to procure motive power from the gases generated by the ignition of gunpowder.

In 1690, Papin experimented in the same direction, but did not seem to achieve any useful permanent results. His mode of operation was to expel the air from a large vessel through check valves opening outwards, and upon cooling to make use of the force of the atmosphere flowing into the partial vacuum or rarefied gases in the cylinder. This force was made available by a piston working in the vessel, to

which piston was connected a weight to be lifted or other work.

This cannot strictly be called a gas engine as the explosion of gunpowder, containing within itself both elements, oxygen and the combustible so little resembles the explosion of gases made explosive with oxygen supplied from the atmosphere as to make the operation of such inventions entirely dissimilar.

The first appearance of record, among the patents for gas engines, properly so-called, is in Robert Street's British patent, No. 1,983, of 1794. In it is a cylinder provided with a piston connected by a lever to a pump. Heat is applied to the bottom of the cylinder, and a small quantity of spirits of turpentine was admitted to the cylinder and evaporated by the heat.

The piston moved upward and air entering mixed with the turpentine formed inflammable vapor; the flame applied at an aperture, ignited the mixture of air and inflammable vapor, and caused an explosion, driving the gas piston up and the pump piston down, thus working the pump to raise water.

A considerable interval of time elapsed before any other recorded gas engine appeared.

Samuel Brown, in his British patents respectively numbered and dated 4,874 of 1823 and 5,350 of 1826 (*Fig.2*), shows a gas engine, which, whilst possible to work, does not promise any economy, and is very cumbrous as compared with other devices, giving the same amount of power. It consisted of a series of vessels, in each of which in regular succession the air was excluded and expelled by flame produced therein. Each vessel was then closed and the rarefied air contracted by jets of water injected and cooling it.

The immediate motive force with this apparatus was the atmospheric pressure pressing into the partial vacuum.

In connection with this series of vessels, Brown employed several cylinders resembling the pistons and cylinders, and valvular constructions for admission and exhaust of direct acting steam engines, the pistons of which were attached by connecting rods to cranks placed equi-distant angularly in a

shaft so as to produce rotation of the shaft, the air flowing into the vacuum performing the same function that steam does in propelling the piston of an engine. The several chambers in which the vacuum was produced were operated successively, so that while one was being charged with gas and air, another was being cooled, and a third one was drawing in the air propelling the engine pistons.

Whilst this engine partakes very little of the character of the present modern gas engine, it bears about the same relation to the present gas engine as the early steam water-raising devices of Newcomen and Savery do to the present steam engine.

The next recorded invention is that of Wm. L. Wright's British patent, 6,525 of 1833 (*Fig. 3*). In this a double-acting cylinder and piston, like the piston and cylinder of the steam engine, was propelled directly by the explosion of a mixture of combustible gas and air acting directly upon a piston, and imparting motion through the usual devices of crank, connecting rod and a rotative shaft.

The air and gas were compressed by separate pumps under low pressure into reservoirs, and was thus forced into chambers at the end of the working cylinder, after ejecting or displacing the gaseous products, from the former stroke by the return stroke of the piston, the gas was ignited as the crank passed the centre; that is to say, when the piston was at rest, the explosion forcing the piston through its whole stroke. At the end of the stroke the exhaust valve opened, and the gases resulting from the combustion were discharged by the returning motion of the piston up to a point where the charge was introduced, when the charge was compressed ready for the next stroke; the ignition was effected by a flame passing through an aperture into the cylinder.

No record appears of this engine ever having been made, although the drawing and specification illustrated and described its construction and operation very fully and clearly.

The cylinder and piston are cooled by a water-jacket, as in modern gas engines.

Next succeeding this is the engine shown in Wm. Barnett's British patent, No. 7,615 of 1838, and was a much more complete and better illustrated invention than any preceding one (*Figs. 4, 5* and *6*). The present system of igniting flame first appears in his invention.

Barnett's description in his patent embraces a single acting engine, and two forms of double-acting engines, all of which compress their charge of air and gas previous to igniting it.

This compression in the first two described forms of engines is effected by pumps, and receptacles distinct from the motor cylinder. The third form receives the charge of the explosive mixture from the pumps directly into the motor cylinder and the motor piston completes the compression of such charge.

The ignition takes place at the commencement of each stroke; that is to say, as the crank passes the centre.

The igniting apparatus consists of a hollow conical plug, which contains a gas jet tube, and has upon one side an aperture which on one position opens, so as to ignite the jet in the plug from an external gas jet. In another position, it closes the connection with the atmosphere and external gas jet, and opens communication with the motor cylinder. A portion of the compressed charge of air and gas entering the hollow plug causes ignition and explosion of the charge in the motor cylinder, and is substantially the present flame ignition system that is practised in modern gas engines.

On page 102, vol. xlv, JOURNAL OF THE FRANKLIN INSTITUTE, there is a brief description of the gas engine, patented October 7, 1846, in the United States, by Stuart Perry, of New York City. The drawing only has been published by the Patent Office, and is here reproduced (*Fig. 7*). In it the cylinder is surrounded with water, the gas is generated in the engine in a retort, the piston was to be lubricated with water, the gas ignited by platinum heated by gas jets in a chamber communicating at intervals through a valve with the explosive chamber.

Considerable attention appears to have been directed

towards the improving of gas engines by a number of applications for British patents, which took place between the date of Barnett's invention and 1855, most of which patents were not perfected, but were merely granted for provisional protection.

In the absence of any complete specifications of them, we, of course, are not informed as to their precise construction.

In 1855, Dr. Drake, of Philadelphia, made a gas engine, and patented it in the United States, on the 17th of April, 1855, in letters-patent No. 12,715, and communicated the invention to Alfred Vincent Newton, the invention is set forth in British patent 562 of 1855. The drawing of the United States patent is here shown (*Fig. 8*).

This engine has a double acting cylinder and piston, and receives a charge of mixed air and gas for part of the stroke, which becomes ignited by the piston uncovering an aperture about midway in length of the cylinder communicating with a cavity having in it a cup of metal or thimble heated to incandescence by an external blow-pipe flame.

This appears to be the first instance in which the gas was ignited by metal heated to incandescence by an external flame; the same device has since then frequently reappeared in other inventions.

Whilst Dr. Drake's engines were well known to numbers of persons in this city, and exhibited in operation to many who are still living, it does not appear that they were ever introduced commercially into use.

In the patent of Great Britain, granted to Barsanti and Matteucci, No. 1,655, of 1857, another type of engine appears (*Fig. 9*); in this a cylinder is provided with an air-tight piston free to rise and fall in it, with a rack attached to the upper side. The piston was elevated or projected upwards in the cylinder by an explosion of a mixture of gas and air beneath the piston and the rack engaged in, and turned a pinion upon a shaft bearing a fly-wheel. The gases cooling in the cylinder, the piston was forced downwardly by its own weight, and the pressure of the atmosphere into a partial vacuum in the cylinder, and turned the shaft by means of the pinion.

A valve at the base of the cylinder served to discharge the products of combustion, and a cam, on the shaft operating tappets upon the rack, served to again elevate the piston a little distance, so as to introduce a fresh charge of air and gas, which was ignited like the previous one and raised the piston again. A ratchet and pawl were provided, so that the shaft should move in one direction continuously, and offer no impediment to the turning of the pinion during the rise of the rack and piston.

These engines were afterwards, about 1867, improved and manufactured by Messrs. Otto & Langen, who added a centrifugal regulator controlling the igniting apparatus, and a cooling jacket to the cylinder (*Fig. 10*).

They were noisy, but were quite extensively introduced, and will be remembered by many as a feature of the Centennial Exposition, in this city, in the exhibit of Otto & Langen, and were commercially successful.

Lenoir's engine (*Fig. 11*) made its appearance about 1860.

In this machine the gas was admitted alternately on either side of the piston, working in the water-jacketed cylinder, and ignited by an electric spark from a Ruhmkorff coil and voltaic battery.

This engine found considerable sale, but was not economical and soon fell into disuse. The cylinders and pistons required frequent cleaning (with Philadelphia city gas daily, and even oftener), and the electric igniting device demanded almost constant attention to keep it in operative condition. Attempts to remedy their defects appear in the United States and British patent records, but seem to have been ineffectual.

In 1867, the Otto & Langen engine was introduced at the Paris Exposition. Its general construction we have already referred to in speaking of the Barsanti and Matteucci engine upon which it improved and showed some appearance of economy—forty-four cubic feet of illuminating gas producing an effective horse-power per hour, which was less than fifty per cent. of that required by the Lenoir or Hugon engine.

Pierre Hugon's first engine, patented to him in the

United States, January 19, 1864 (*Figs. 12, 13 and 14*), operated by displacing a water column by the explosion of air and gas, and moving the power piston in a cylinder by the reaction of the pressure of the water column, the purpose being to secure longer and more uniform action. This was speedily followed by his engine, patented August 8, 1865, in letters-patent of the United States No. 49,346 (*Fig. 15*); the latter being merely the Lenoir engine, with a flame ignition substituted for the electric spark. This ignition apparatus was in the form of a slide instead of the rotative device of Barnett. It is of the general character of the igniting slides now used in gas engines.

In 1876, the Otto "Silent" appeared, which embodied a scheme or method of working, described by Beau de Rochas, in a pamphlet published in Paris in 1862, which is here shown in the drawings from his United States patent 190,047, dated August 14, 1877 (*Fig. 16*). In this the piston derives its impulse from gas compressed in a chamber at one end of the cylinder, and having completed its outward stroke returns whilst the exhaust remains open, and the products of combustion resulting from the explosion and combustion in the outward stroke are expelled, as nearly as may be, by the next out-stroke which is made with the exhaust valve remaining open; the supply of fresh air and gas commingled with it, is received in the cylinder; the exhaust valve now closes, and the returning stroke of the piston, produced by the momentum of the fly-wheel and action of the crank and connecting rod compresses the charge of gas into the chamber at the end of the cylinder, and being ignited, another propulsion of the piston takes place, during one outward stroke only in every second revolution. In other words, three strokes of the piston without any development of power must occur to procure one stroke from which the fly-wheel and connecting parts receive any impetus.

This cycle of working is an essential characteristic of the modern gas engines of Otto, and the function effected by it of compression of the charge of gas and air are characteristic of all the present economical gas engines. The several inventions for improvements in gas engines are for the means and methods of effecting such functions.

The Otto gas engine has been improved in its details by Wm. J. Crossley, of Manchester, England, who has given the invention its present well-known form. There have been many improvements in details patented, which it is unnecessary to particularize in this report (*Figs. 17, 18 and 19*).

In the Clerk gas engine (*Figs. 20, 21 and 22*), the functions of purging, charging and compression are effected by means of pumps supplying air and gas. It will be seen upon inspection of any of these gas engines that the space occupied by the charge at the commencement of the power stroke, is beyond the displacement of the piston, and therefore may retain a portion of the products of combustion from the previous power stroke, which dilutes the next charge and impairs its effect.

The method of operation of all gas engines, as compared with other heat engines, as for instance steam, is essentially dissimilar. In the steam engine the heat is imparted to the fluid by conduction, a great deal of heat is required in converting water into the gaseous state or steam, and a great deal of heat is wasted, both in the combustion of the fuel and in its transmission through the material of the boiler, as well as by conduction and radiation from the pipes, valves, cylinders, etc. In the best steam engine this is diminished to the lowest point practicable by working rapidly, thus avoiding long contact of the steam with the working parts of the engine, and by protecting against radiation by slow conducting coverings. In the gas engine, the expansible fluid is atmospheric air, the fuel is the gas, which is commingled with the air, and contributes to its volume, and when ignited imparts its heat directly to the mixture instead of transmitting it through any intervening partition. The sources of loss of power in gas engines are the cooling of the gases and the air before imparting their force to the moving piston.

It is necessary in these constructions, from the high temperature resultant from the explosion or the combustion of the gas and air to maintain the cylinder at a much lower temperature than that of the gases, so that the correct fitting of the piston and cylinder may be preserved. This

is done by a circulation of water through a jacket surrounding the cylinder.

The best economy would indicate that the greatest capacity of the cylinder with the least surface would be the best proportions for such cylinders, and practice appears to verify this inference. To utilize the force with the least waste from conduction by the cylinder, and the quickest transmission of the force from the exploded gases through the moving piston to the fly-wheel (which is the reservoir of power in these engines), have proved to be the best practice.

The Atkinson gas engine (*Fig. 23*), which is the subject of examination and test by this committee, is an endeavor to combine these several indications of economical practice in a simple machine. Instead of making the two revolutions of the crank shaft to procure one impulse from the explosion of gas and air, the piston of this engine is connected indirectly by a peculiar system of lever and link or connecting rod to the crank, so that when the crank makes one-half revolution the piston passes out to the front or open end of the cylinder and returns close up to the back end thereof.

In the next half revolution, the piston passes out midway toward the front end of the cylinder, and makes only a partial return stroke, during which time it receives and compresses a charge of gas. This is ignited, and the piston is propelled outward a full stroke in less than a fourth revolution of the crank, and returns close to the back end of the cylinder, displacing all the products of combustion from the previous stroke, and leaving the cylinder free to receive an entire charge of air and gas.

The expansion of the charge after explosion is to about double its original volume and down to atmospheric pressure, thus utilizing all the force generated and not absorbed by the cylinder and piston as heat. The exhaust, as a consequence, is noiseless.

The arrangement of levers and links for effecting this are shown in the drawings marked *Fig. 1*, which show a lengthwise vertical section of the engine. The angular distances through which the lever, link and crank operate upon each other in performing their several functions, are shown in *Fig. 24*.

The distribution of force is shown in *Fig. 25*, as is also the pressure upon the piston by an indicator diagram on the same figure.

The resistance encountered during the short compression stroke is shown in the triangular shaded lower left portion of the diagram, whilst the large triangular part of the diagram represents the development and utilization of force. The relative areas of these figures indicate the extent of charge consumed and the economy derived from the expansion of the products of the explosion.

It will be seen that the absorption and transmission of power from heated gases through the piston, lever, link and crank to the fly-wheel is through a very short fraction of a revolution. The construction of the details of the engine is shown in the remaining figures. The admission of gas is made through an annular port surrounding the air-admission valve and ensures the mixing of the air and gas as they enter. The exhaust is discharged through a poppet valve controlled by a cam, and both valves are brought to their seats by a single spring operating a yoke to the ends of which these valves are connected. The regulation of velocity is by a centrifugal governor, which moving a block to one side or the other, as the speed may be accelerated or retarded, connects or disconnects the gas-admitting valve from its operating cam.

The ignition of the gaseous mixture is effected by a tube closed at the outer end, with one end open to the cylinder and the other closed and heated by an external flame from a Bunsen burner located inside of a non-conducting chamber or chimney.

It is found by observation that the six-horse engine under examination steadily maintained a remarkable uniformity of speed.

Two tests were made of the engine by your committee.

Records of these tests are here tabulated and shown. The engine was rated commercially as a six-horse-power engine. It developed a brake power in one experiment of 10·3 horse-power with an expenditure per brake-power of 22·25 cubic feet of gas hourly per brake.

Upon the second test it developed 8·6 per brake horse-power with the expenditure of 22·3 cubic feet of gas per hour per horse-power.

In making these tests the quantity and increase of temperature of cooling water were carefully noted.

For the purpose of ascertaining and apportioning the causes of loss or disappearance of the force due to the explosion of the gas consumed, the following data are submitted:

Assuming that the quality of gas supplied from the city works of Philadelphia to be equal to that of the London Gas Works, and containing 638·7 units of heat per cubic foot, then the absorption of the power appears in the work done on the brake, as 18·132 per cent. of the theoretic power of the gas. 26·87 appears in increased temperature of the cooling water, and the balance, about $\frac{35}{100}$, disappears as chargeable to losses by radiation, friction and imperfect combustion.

This while it looks very wasteful, when we consider how very little the best steam engines show of useful effect for the units of heat contained in the fuel, is not only remarkably good economy, but shows an inviting field open to further experiment, and promising remunerative economy.

The engine tested by your committee is of foreign manufacture. The manufacture of such engines embodying this invention is now being commenced in this city and promises to become an important industry.

In preparing the report your committee found it requisite to a clearer understanding of this subject to examine all of the specifications of the United States patents on this subject. In so doing they, of course, found much that was irrelevant to their present inquiry, but to discover what was requisite to guard against mistakes in finding the state of the art, no other course appeared safe.

The United States patent specifications and drawings inspected in this case number 188 patents, many of them containing several sheets of drawings. The foreign patents, some twenty-seven, are for the most part repetitions of the American patents.

The conclusions indicated by the test are that James

$\frac{192·8}{8·6}$ = 22·3 cubic feet of gas per hour per brake horse-power.

ATKINSON GAS ENGINE.—TEST II.

Time.	Difference.	Gas.	Counter	Difference.	Gross Load.	Net Pull.	Net Load.	Water. Gross.	Water. Net Pounds.	Water. Temperature Inlet.	Water. Temperature Outlet.	Remarks.
h. m. s.					*pounds.*				*pounds.*	*deg. F.*	*deg. F.*	
2 33 50	. . .	0	39,553	. . .	133	1'5	. . .	. . .	. . .		. . .	
37 10	3'20	10	935	382	. . .	1'5	. . .	. . .	. . .		. . .	
40 25	3'15	20	40,309	374	. . .	1'5	. . .	. . .	. . .		. . .	
43 33	3'8	30	683	374	. . .	1'5	. . .	. . .	. . .	43	111	
46 47	3'14	40	41,055	372	. . .	1'5	. . .	. . .	. . .	43	107	
49 57	3'10	50	424	369	. . .	1'5	. . .	. . .	. . .	43	110	
53 0	3'3	60	790	366	. . .	1'75	. . .	. . .	. . .	. . .	114	Missing about 10 per cent. charges.
56 4	3'4	70	42,156	366	. . .	1'8	. . .	. . .	. . .	. . .	120	Little more water.
59 7	3'3	80	520	364	. . .	1'8	. . .	. . .	. . .	. . .	116	
3 2 10	3'3	90	885	365	. . .	2'	. . .	. . .	. . .	. . .	115	
5 15	3'5	100	43,250	365	. . .	2'	. . .	. . .	. . .	. . .	113	
8 22	3'7	110	618	368	. . .	2'	. . .	. . .	. . .	. . .	111	
11 25	3'3	120	982	364	. . .	2'	. . .	. . .	. . .	. . .	107	
14 34	3'9	130	350	368	. . .	2'	. . .	. . .	. . .	. . .	104	
17 39	3'5	140	719	369	. . .	2'	. . .	. . .	. . .	. . .	. . .	
20 43	3'4	150	45,088	369	. . .	2'	. . .	. . .	. . .	. . .	98	
23 47	3'4	160	459	371	. . .	2'25	. . .	. . .	. . .	. . .	97	
26 50	3'3	170	815	356	. . .	2'25	. . .	. . .	. . .	. . .	92	
30 0 0	3'10	180	46,183	368	. . .	2'25	. . .	. . .	. . .	. . .	92	
33 5	3'5	190	541	358	. . .	2'5	. . .	. . .	. . .	. . .	92	
36 5	3'5	200	46,913	372	. . .	2'5	. . .	. . .	. . .	. . .	93	
						21)40'10					17)1'792	
1 2 15	1 2 15	200	7,360	7,360	133	— 1'91 =	131'09	. . .	546	. . .	705'4 — 43 = 62'4	

Duration of test, 62¼ minutes.

Net load on brake, 131·09 pounds.

Total revolutions, 7,360.

Revolutions per minute, $\frac{7,360}{62\frac{1}{4}} = 118{\cdot}26$.

Effective circumference of brake, 18·26 feet.

$$\frac{131{\cdot}09 \times 18{\cdot}26 \times 118{\cdot}26}{33{,}000} = 8{\cdot}6 \text{ BRAKE HORSE-POWER.}$$

$$\frac{200 \times 60}{62\frac{1}{4}} = 192{\cdot}8 \text{ cubic feet of gas per hour.}$$

$\frac{192{\cdot}8}{8{\cdot}6} = 22{\cdot}3$ cubic feet of gas per brake horse-power.

Time 32¼ minutes.
Total revolutions, 4,138; per minute, 128·3.
Net mean load, 141·46.
Gas in 32¼ minutes, 120 cubic feet.
Circumference, 18·24 feet.

$$\text{Brake horse-power, } \frac{18{\cdot}24 \times 128{\cdot}3 \times 141{\cdot}46}{33{\cdot}000} = 10{\cdot}03$$

Gas per hour, 22·32.
Gas per brake horse-power per hour = 2·25 cubic feet.

NSON GAS ENGINE.—TEST II.

Net Pull.	Net Load.	Water.				Remarks.
		Gross.	Net Pounds.	Temperature		
				Inlet.	Outlet.	
			pounds.	*deg. F.*	*deg. F.*	
1·5	. . .	. . .	. . .		. . .	
1·5	. . .	. . .	. . .		. . .	
1·5	. . .	. . .	. . .		. . .	
1·5	. . .	. . .	. . .	43	111	
1·5	. . .	. . .	. . .	43	107	
1·5	. . .	. . .	. . .	43	110	
1·75	. . .	. . .	. . .	. . .	114	Missing about 10 per cent. of charges.
1·8	. . .	. . .	. . .	. . .	120	
1·8	. . .	. . .	. . .	. . .	116	Little more water.
2"	. . .	. . .	. . .	. . .	115	
2"	. . .	. . .	. . .	. . .	113	
2"	. . .	. . .	. . .	. . .	111	
2"	. . .	. . .	. . .	. . .	107	
2"	. . .	. . .	. . .	. . .	104	
2"	. . .	. . .	. . .	. . .	. . .	
2"	. . .	. . .	. . .	. . .	98	
2·25	. . .	. . .	. . .	. . .	97	
2·25	. . .	. . .	. . .	. . .	92	
2·25	. . .	. . .	. . .	. . .	92	
2·5	. . .	. . .	. . .	. . .	92	
2·5	. . .	. . .	. . .	. . .	93	
140·10					17)1792	
1·91 =	131·09	. . .	546	. . .	105·4 — 43 = 62·4	

Committee on Science and the Arts, FRANKLIN INSTITUTE.

ATKINSON GAS ENGINE.—TEST I.

Time.	Counter.	Revolutions as per Counter.	Gross Load.	Negative Pull.	Net Load.	Gross.	Remarks.
345·50	32·397	. . .	145¼	8	137·25	0	
48·45	·758	361	145¼	5¼	140 0	10	
51·32	33·111	353	145¼	1¼	14·40	20	
56·20	·455	344	145¼	⅛	144·75	30	
57 7	·799	344	145¼	⅛	14·50	40	
59·50	34·130	340	145¼	⅛	14·50	50	
8·35	·473	334	145¼	⅛	14 50	60	
5·8	·805	332	145¼	⅛	14·50	70	18, 1¾
7·55	35 138	333	145¼	¼	14·50	80	
10·35	464·	326	145¼	0	145·85	90	Removed 3·12 portion of load.
13·25	·811	347	134¼	0	134·25	100	
·15	36·179	368	134¼	0	134·25	110	58, 4¼
18·5	36 525	356	134¼	0	134·25	120	59, 5¼
32·15	41·38	4,138			13)1,839·00 141 46		450

Time 32¼ minutes.
Total revolutions, 4,138; per minute, 128·3.
Net mean load, 141 46.
Gas in 32¼ minutes, 120 cubic feet.

Atkinson's gas engine surpasses all preceding gas engines in simplicity, economy, perfection of regulation, and uniform steadiness of power, and is deserving of recognition by an award of the John Scott Legacy Premium and Medal.

[Signed] S. LLOYD WIEGAND,
Chairman Sub-Committee.

WM. H. THORNE, LUTHER L. CHENEY,
COLEMAN SELLERS, E.D., SAMUEL R. MARSHALL,
MOSES G. WILDER, ARTHUR BEARDSLEY.

Adopted May 9, 1889.

[Signed] S. LLOYD WIEGAND.
Chairman Committee on Science and the Arts.

BLINDNESS AND THE BLIND.

BY L. WEBSTER FOX, M.D.

[*A lecture delivered before the* FRANKLIN INSTITUTE, *February 25, 1889.*]

The Lecturer was introduced by Prof. EDWIN J. HOUSTON, of the INSTITUTE, and spoke as follows:

MEMBERS OF THE INSTITUTE, LADIES AND GENTLEMEN:

"The character of a man may be read in his face."* I make an addendum and say, a man's character may be read in his eye. Physiognomy is understood by all to a greater or lesser degree. The physiognomy of the eye is the more subtle science, hence requiring a more extended study.

The eye is an index to the workings of the brain: "It participates in all its emotions, expresses the most lively sensations, passions the most tumultous, feelings the most delightful and sensations the most delicate."† One author calls it, "The tongue of the understanding."

We all feel that vision is the most valuable of the senses, for by it we enjoy the beauties of nature, it is also a source of our learning and a medium of communication. While

* Lord Kames. † Lavater.

modern methods have given the blind better advantages for knowledge, yet even the senses retained by the blind seem to be less acute to external impressions, than to those who have vision.

The most unfortunate affliction to any one, is to lose his sight. Goethe says: "To live and not see is unfortunate." Milton, the great poet, suffered with a disease of his eyes which eventually ended in blindness. At that time the nature of his malady was not understood. Science has advanced, and such cases are now successfully treated. Milton's blindness was to him a great grief. His mind was of the brightest, and most prolific in gems of noblest thoughts.

One could almost fancy that he would have lived within himself and been happy with his thoughts, but no, he says:

> "Thus with the year,
> Seasons return, but not to me returns
> Day, or the sweet approach of eve or morn,
> Or sight of vernal bloom, or summer's rose
> Or flocks or herds or human face divine:
> But clouds instead, and ever during dark
> Surround me, from the cheerful ways of men
> Cut off, and for the book of knowledge fair
> Presented with a universal blank
> Of nature's works, to me expunged
> And wisdom at one entrance quite shut out."

In strolling through an unfrequented street of London, several years ago, I found on the shelves of an old book stall, a book which attracted my attention, the title of which was, "Blindness and the Blind." It was of more than ordinary interest to me, and from time to time I have read it with renewed interest. From its title, I have taken the subject for my lecture this evening, and as I have gained much information of interest to me from this work, I have taken the liberty of making several extracts from the same.

Probably at no time in the history of the science of medicine has there been so much attention given to the effort to prevent blindness, correcting visual defects, or

operations devised for the restoration of vision, than at the present day.

In my rambles through the picture-galleries of Europe, I do not remember of ever seeing a single portrait where any defect of the eye had been noted. It would be difficult to portray a cataract, but one would expect to see an occasional crossed eye. Sometime ago I had the opportunity of becoming the owner of a few engravings of celebrated men of years ago. In this collection, I found two defects, one a crossed eye, the other, where the color of one was unlike its fellow, one being gray, the other being black or brown. I remember having once seen a negro child whose color indicated a pure African descent, yet this child had beautiful blue eyes.

Before entering into the subject germane of my lecture, I must speak of the very great importance which light plays in the development of vision and the assistance which the eye receives from it in the performance of its functions. The immediate instrument of visual perception, light, enables us to distinguish colors, to recognize form and to measure distance. Light may be too intense, too overstimulating, when this takes place we are as liable to have blindness as in its absence.

Any theory which supposes the properties of an external world to be only those which the mind can create for itself, mistakes the question. External properties may, and do, exist without our perception of them, and any failure to perceive is not proof against an external existence. Others may, and do, see that which we, for a time, fail to see, or have not the capacity for seeing.

The overstimulating effect of light on the human eye is to be noted by the effects produced. Since the introduction of the electric light into workshops, a new disease has developed. I may state that as soon as the attention of the medical profession was called to this fact, the light was rendered less intense, and the evils caused by it have disappeared. Occasionally we still find workmen who are subjected to this torture. It is a well-known fact that men who work in furnaces or puddling mills are subject to premature cataracts.

The enthusiast, who watches a solar eclipse without protecting his vision, pays for his rashness by developing a central blind spot which may not disappear for years, or may leave him permanently blind. Dr. Whitney reported seven cases of premature injury to the vision in Japanese students from exposure to sunlight during the last eclipse. On another occasion, an engineer was rendered blind by exposure to the light of a powerful electric arc. The intense glare of the snow is also productive of blindness. It is not unusual for woodsmen or hunters to become so affected. The intense glare of the tropical seas also produces blindness, known as "moon-blindness," erroneously attributed to the effect of the rays of the moon, but in reality caused by the sun's rays.

Light is essential for the development of vision, as the retina must have a certain amount of stimulus to develop its action. In illustration of this fact we may simply refer to the blind fish of the Mammoth Cave.

Disease, in various forms, plays a part in causing blindness. At one time small-pox was a most prolific cause of loss of sight. Measles and other eruptive fevers still cause much blindness. In thickly populated countries, where about one-third of the population become affected, visual defects, in consequence, are enormously great. In hot and dry countries ophthalmia is exceedingly prevalent. Napoleon, when in Egypt, had at one time about one-fourth of his army affected. This form of disease is exceedingly contagious, and a similar form of disease finds its origin in schools and institutions where cleanliness is overlooked.

Epidemics of pink-eye still live within the recollection of many present this evening. While these diseases do not, as a rule, lead to blindness directly, yet the secondary results are baneful.

In looking over the statistics, I find that the social life of a country has much to do with the development of vision. The Germans are proverbially near-sighted. In walking through the street of any garrisoned city of the German Empire, one is struck by the number of officers wearing glasses. The English, as a nation, are far-sighted. In our

own country we find the same law holding good. The community, descendants of English, retain this primal defect of their ancestors. The German community the same. Where there has been a commingling, the prepotency of the stronger is shown, and the "American eye" is the result. By this I mean the astigmatic eye. Astigmatism may be either of that kind known as far-sighted or near-sighted, or a mixture of both.

A very interesting examination of Indian school children was made by myself some years ago. Those just from their Western homes or those who had been in school but a very short time I found had exceedingly good vision, above the average of the American boy or girl. When I came to examine the boys and girls of the Creek tribe, here I found that civilization had placed her hand upon them. Near-sighted ones were common. This tribe, let it be remembered, have been more or less civilized for fifty years.

To prove still farther that class application, and especially the amount of study now required by teachers and possibly by directors of our public schools, is making the younger generation a generation of myopes or near-sighted individuals, let me quote from Dr. Cohn, who examined 10,000 school children, 17·1 per cent. or more than one-sixth of whom were near-sighted. No village children were found to be short-sighted until they had been at least half a year at school. Dr. Derby, of Boston, found the same defect co-existing to a greater or less degree with the time students had spent at Yale. My friend, Dr. Risley, of this city, some years ago, made a careful examination of the eyes of children attending the public schools. He found many defects. Beer, the famous ophthalmic surgeon, seventy years ago wrote against forcing school children. He said: "I have done much to impress upon parents and friends, in the most friendly manner and upon the most convincing grounds, the mischievous effects upon the eyes of growing children of the forcing system of the present day in schools." Note the result. Anyone who has travelled through Germany or Austria is struck by the number of

individuals wearing glasses. Three generations have passed away since Beer wrote the above sentences, but his prophecy has born its fruit. The Germans are to-day a near-sighted race.

Workmen on fine work always complain of defective vision. So common are these troubles that physicians have long ago ceased to give such diseases technical names, but such names as illustrate the occupation of the individual.

The ancients knew that the glare from white hot metals would cause blindness in a very few moments, and was a frequent means of punishment for their criminals or prisoners of war. It was supposed that Samson was in this way blinded by the Philistines. Nebuchadnezzar blinded Zedekiah by this means. Levy tells us that Pope Paschal, in 824, put out the eyes of every monk who preached fidelity to the Emperor of Germany. In 873, Charles the Bald, King of France, put out the eyes of one of his sons, who, having been made a monk against his will, had escaped and set his father at defiance. In 1004, the King of Poland conquered Bohemia and destoyed the vision of its duke. These horrors are surpassed by the fiendish conduct of the Emperor of Basilus, who, having in 1013 defeated the Bulgarians, put out the eyes of his prisoners, 15,000 in number, leaving only one person in a hundred with one eye to guide the sightless beings to their homes. Even in England, blinding prisoners of war or state was a common mode of punishment. It is said that Ivan the Terrible, Czar of Muscovy, after the completion of the cathedral in Moscow, had the eyes of the architect put out, lest he should ever construct another building equal to it in beauty.

As I stated previously, ophthalmia was a prolific source of blindness. It is said that in the twelfth century the streets of English towns were beset by Crusaders who had returned from the Holy Land, where they had lost their vision from this disease. In France, the attention of good King Louis IX was called to the large number of these blind individuals wandering about the streets of Paris, and, in 1260, founded an institution for their reception, where, to this day, the good work then done is shown in the magnificent

institution, where the blind from all parts of France are admitted. I visited this institution recently, which is now the oldest institution for the blind in Europe. At this time I take the opportunity of mentioning, and with just pride, that among the many charitable institutions of Philadelphia, none rank higher in their record of good work than the Institution for the Blind, at Twentieth and Race Streets.

There is one kind of blindness, I am sorry to say, for which the American Continent may be held responsible. While many cases do not exist, yet they are to be found. I believe, however, that it is a more frequent source of injury to vision than we like to admit. I refer to the abuse of tobacco. Tobacco abuse, while it may lead to absolute blindness, first may weaken the muscles of accommodation, thereby causing no end of visual difficulties, but also producing loss of power in recognizing colors or color-blindness, a defect, which, when existing among engine drivers, may peril the lives of many people entrusted to their care. At the last meeting of the British Medical Association, held in Glasgow, Dr. Bickerton, of Liverpool, read a paper on "Sailors and their Eyesight," including color-blindness. He is persuaded that many accidents at sea, both collisions and strandings, are caused by defective eyesight. To begin with color-blindness, Dr. Bickerton gives two cases in which accidents have been proved to have been directly due to this cause. Both accidents happened in our own country. The first is a collision which took place, in 1875, near Norfolk, Va., between the steam tug *Lumberman* and the steamer *Isaac Bell*. The master of the former vessel asserted that before the collision he saw the latter's red or port light, and manœuvred his own ship accordingly. All the other evidence proved beyond a doubt, that only the green or starboard light of the *Isaac Bell* could have been visible to the *Lumberman*. The master's mistake, through which ten lives were lost, remained inexplicable until a surgical examination, four years later, proved him to be color-blind. These facts are attested by the Annual Report for 1880 of the United States Inspector General of Steam Vessels. The second case is given on the authority of the

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Shipping and Mercantile Gazette and Lloyd's List. It is there stated that the steamer *City of Austria* was lost in the harbor of Fernandina, Florida, in April, 1881, owing to the defective eyesight of the pilot, who was unable to distinguish the colors of the buoys. Dr. Bickerton, in addition, mentions the collision which took place last January between the *Toronto* and the *Freidis*, in St. George's Channel. In that case, according to the evidence given at the Board of Trade inquiry, the lookout man saw, before the collision, only a green light; while the captain, mate and quartermaster saw first a red and then a green one. The man denied that he was color-blind, but, as Dr. Bickerton stated, it was in the last degree unlikely that he would admit such a defect. The last instance given is the too notorious collision between the *Vanguard* and the *Iron Duke*, in 1875. That collision was due to the fact, that the *Iron Duke* steered out of line just when the *Vanguard* was slackening her speed, and this reduction of speed, without which the collision would not have taken place, was due to the report of the lookout man that a ship was crossing the bows of the iron-clad. Nobody else saw this ship, though four other men were on the lookout, and the man who reported her admitted afterwards that his eyesight was defective and that he had been twice treated for blindness of the right eye. The facts of this case are given on the authority of the official reports of the court martial; and here, at any rate, it seems clearly established that defective eyesight was a contributing cause of a most disastrous collision. On board the ships of our Trans-Atlantic lines, we believe, the utmost care is taken in the selection of men for the responsible post of lookout. As Lord Brassey, speaking of the *Vanguard* case, said in the House of Commons: "The entire management and manœuvring of a ship by the officers in command may depend on the experience and judgment of the men on the lookout aloft, and if they are not efficient, the gravest consequences may ensue." It therefore becomes evident that as long as signals at sea are given by colored lights, color-blindness is a fatal defect in a lookout man, and as the side lights, which every vessel carries to indicate her position

and course, are red and green—the two colors most commonly confused—the defect, when it exists, is particularly apt to lead to disastrous results. In fact, the authorities have recognized the force of these *a priori* considerations by making it compulsory upon all persons presenting themselves for officers' certificates to submit to a color examination. In our country, the subject of color-blindness has received much attention, and we may all feel sure that our engine drivers are men who can distinguish the difference in shade between a bright scarlet or a green light. When we know that forty men out of every thousand have this defect to a greater or less degree, we see the importance of having such men undergo an examination. It would be to the advantage of all boys to undergo such an examination once in their school life. Where the defect exists, let them know it, and their life work be so arranged for them that at some epoch in their lives they may not find themselves disqualified for following an occupation selected for them. A color-blind would be useless where the selection of color entered into his life work. Color-blinds make the best etchers, steel engravers, or wood engravers, for they possess what is known to their profession as the "recognition of tone." The man having normal color-sense depends on shade. But two women in one thousand are color-blind. The savage races possess the perception of color to a greater degree than the civilized races. In an experience of ten years I have found only one individual who was totally color-blind. Those blind to red and green, as I stated previously, are common. The usual tests for color-blindness are the matching of wools. Not the naming of colors, as names vary, and what might be called light green, might in some other language be called a light blue, and the individual who makes the assertion be perfectly correct. A person might in this way be put down as a color-blind, when it was simply a case of mistaken nomenclature.

A color-blind engineer on a clear night could not very easily make a mistake in recognizing his danger signal, for he will long before have learned that the light from the red light is not as clear as that from a white or even so much as

from a green. This is the reason why it is found that color-blind engineers have escaped accidents. I can recall an incident of this kind. A number of color-blinds were tested in the ordinary way, by red and green lights. It was soon found that two out of three men recognized the colors correctly. Our tests were carried on in the open air on a dark, but clear night, with the stars shining bright. It puzzled us very much. Suspecting that the men had certain information which they were using, they were taken into a building and submitted to the same tests, with a result which proved them to be color-blind. They then confessed that they had used a bright shining star as their guide. The light from the green light approached the light emitted from the star, yet when the red light was turned on, the light was not nearly so bright as the white or green light. One of the simpler ways of testing for this defect, is by placing before the candidate a large collection of wools, including all the chief colors, and several shades of each. Prof. Holmgrens test is to choose a rose color. The candidate will then be asked to match it. If his perception is good he will promptly select the rose wools, if he is red blind he will select the light blue, or violets, if green blind, the light grays or drabs. Rose being compounded of two parts red and one of blue, he would therefore select a blue, to match, as he would think, a blue. The second test would be a more pronounced one. We would then give him a scarlet. To this a red blind would match a dark brown, or a dark green. A green blind, would match a light brown and a light green. Dr. B. Joy Jeffries, of Boston, was a pioneer investigator in this country. It has been suggested that this sense should be developed by training or practice. This is simply impossible. Color-blindness may be the result of disease, brain disturbance, or congenital. One of the most brilliant teachers of Moorsfield Eye Hospital, London, recently went blind from an affection of the optic nerve. The first symptom of failing vision was his loss of color perception.

It is not infrequent to find individuals who work on colored goods, to find certain colors more fatiguing to their

eyes than others. Physicians now recognize a disease known as "weavers' disease." The red colors, which have the longest wave length, exhaust the eye first, the green follows second in order, while the blue is soothing. All are familiar with the phenomena produced by gazing steadily at a red disk or red letters, under bright illumination. Suddenly turning our eyes against a white background, we will soon recognize the same spot or the letters in the same color, which will, in a very short time, be replaced by the complementary color, green. This is due to retinal exhaustion, which for the time is unable to perceive the red element, but sees only the bluish-green produced by the admixture of the still visible green and violet.

Color in medicine may some day play a *rôle*. Psychophysics is a subject which the Germans are now discussing. Dr. Brodham, who has recently been making experiments for the purpose of testing the fundamental law of psychophysics in connection with the sense of sight, says: "If it can become known certainly, that the perception of color has a distinct and important influence upon the arrangement and interaction of the brain cells upon each other, we shall be able to drop the use of drugs to a great extent, and get our curing as we get our ailments, largely through the eye." This quotation has more pith in it than we should at first surmise. Recently I had an individual tell me that the color yellow would produce a nausea, and even an exceedingly bright day would bring about the same affection. A pair of Arundel-tinted glasses gave relief.

Do the blind enjoy the sense of sight in their dreams? This subject has lately been under discussion, and Professor Jastrow, who has personally examined 200 cases, has gathered some very interesting data. Of fifty-eight cases, which he quotes specially, thirty-two became blind before completing their fifth year, and not one of these thirty-two see in their dreams. Six became blind between their fifth and seventh years. Of these four have dreams of seeing, but two of them seldom, and with some vagueness, while two never dream of seeing at all. Of twenty persons who became blind after their seventh year, all have dream vision. Dr.

Jastrow remarks that, "the period of dream vision is from the fifth to the seventh year. If blindness occurs between the fifth and seventh years the preservation of the visualizing power depends on the degree of development of the individual. If the faculty is retained, it is neither stable nor pronounced. If sight is lost after the seventh year, the sight centre can, in spite of the loss, maintain its functions, and the dreams of such individuals are hardly distinguishable from those of a seeing person." Dr. Jastrow brings out the very interesting fact that the chief sense with the totally blind is hearing, and not the sense of touch. Dr. Hermann, in 1858, wrote a very interesting article on this subject. I quote from Dr. Jastrow's paper: "Dr. Hermann records the answers of fourteen totally blind persons who lost their sight previous to their fifth year, and none of them had dream vision. Of four who lost their sight between the fifth and seventh year, one had dream vision, one has it dim and rare, and two do not definitely know. Of thirty-five, who became blind after their seventh year, all have dream vision. Dr. Hermann includes in his list many aged persons, and from their answers is able to conclude that, generally speaking, those who become blind in mature life retain the power of vision longer than those who become blind nearer the critical age of five to seven years. He records twelve cases whose dream vision continues after a blindness of fifteen years, four of from fifteen to twenty years, four from twenty to twenty-five, and one of thirty-five years. In one case dream vision was maintained for fifty-two years, and in another fifty-four years, but these faded out."

I have for more than a year past given much attention to this subject. Those who have been blind from birth, or early childhood, do not enjoy sight in their dreams. For two reasons, first, they, like the rest of humanity, picture in dreams what they are accustomed to do in their day life, and as they do not depend upon sight in the performance of their daily duties, it does not form any part of their dreams. Second, it is impossible for the blind to get a correct definition of sight, how then can the imagination form a picture when the

material with which it is to work does not come under its sway? The pictures formed by the blind in their dreams are as the arch without the keystone; the mass is confused, and the absence of sight, which is the keystone to the mental arch, prevents the dream from being complete. I have talked with those who have lost their sight in later life, and their dreams are similar to those of persons who see. That is to say, if an individual lost his sight to-day he would continue to see forms, but as time rolled on the mental picture would gradually grow fainter and fainter, so that one who had been blind for a certain number of years would never again see form. Those blind from infancy would in their dreams depend upon the sense of touch and hearing, as these are the means by which those who have been deprived of sight are made acquainted with what goes on about them. When such individuals dream, they seem to talk with those who have a part in their dream, and can distinguish their voices as they reply to questions. They may fancy that they see daylight, but such persons always experience a greater sense of loneliness than is actually felt by the blind, when compelled to rely on their own responsibility at such times. A blind person once told me that she dreamed of a human face. It seemed as if she wanted to become acquainted with its shape. She placed her hand over it, and found its shape to be what is termed oval. The expression was absent, but to this blind person the face seemed to lack nothing, for how would it be possible to miss that which she had never seen? One cannot picture the beautiful city of Paris as it really is without visiting it, and can the blind picture that which description fails to make clear?

In some instances, color may be distinguished by persons who have but slight perception of light. In one individual who was thus affected, the two most prominent colors were red and blue; pink and yellow were seen but very indistinctly, the reason being that she had difficulty in distinguishing them at all times, while, on the contrary, red and blue are more readily distinguished. Colors seldom appeared in her dreams, and, when they did, had a faded look. Light

is invariably seen in this patient's dreams. It is clear and silvery. Prof. Helmholtz recently called attention to the sensation of light which we have all noticed in the dark, and when the retina is at rest. This sensation he calls "Eigenlicht," a name which brings us back to the curious belief of the Greeks, and which is said to have been shared in by Descartes, that the eye has a light of its own which it sheds on the outer world.

Another person writes me: "Ocular vision, to a person blind from the time his memory begins, is a far greater stranger than is a view of heaven to the sighted person. The sighted person is able to form some idea of heaven by seeing some beautiful garden and letting his heated imagination play among the beauties and charms there. What has the person always blind to build upon in order to form an idea bearing even the slightest resemblance to ocular vision? When we take sufficient pains, we are able to trace in our dreams the cause to which each particular feature owes its origin. The causes are clear or dim, or almost unrecognizable, just according to the force of the impression upon the mind during wakefulness. Hence, a dream is an after-view of what we experience. How, then, is it possible for a person always blind to dream of seeing?" Several such persons, in answer to my questions, have declared that they have seen in their dreams. However, they failed to draw distinct features of it. Their picture was no picture —a mass void of shape and color. They threw the marble, stone and other materials in a heap, and said: "There's the mansion." I am led to believe that their answer was prompted by a certain unaccountable false shame of theirs in confessing their inability to see in their dreams. Several persons blind from birth, not merely intelligent, but intellectual ones, have told me that they could see in their dreams.

In reference to those who have seen, a young man writes me, "I lost my sight at the age of fifteen. In some of my dreams I see just as I had seen in my former life, partake of the same pleasures, such as reading, skating, base ball, swimming, etc.; and in other dreams I see everything, but

am almost helpless. In travelling the streets for instance, I use my cane instead of my eyes, and on reading I must hold my book close to my eyes, and, as it were, strain my sight, and often the print seems blurred. I often remember what I have read. (I have also composed a stanza of poetry in my dreams, and recited it after waking.)"

Another, who has been totally blind, not even having light perception, writes as follows: "Many persons are of the opinion that the blind can, and do see in their dreams. That during slumber, their eyes as it were are opened and they perceive the rays of light and objects at a distance, which are veiled from them during their waking hours. This erroneous idea is due partly to a want of proper consideration of the subject, and partly, perhaps, to the fact that there are some blind persons who say that they dream of seeing. It is strange how many fallacious ideas there are regarding the blind." There are some blind persons, who, in order to make themselves appear wonderful, often go beyond the bounds of truth, and their statements are too apt to be accepted as facts by the sighted, without considering whether they are true or false. As, for instance, the false notion that the blind can tell color by the sense of smell, or a dollar bill by the sense of touch. "The phenomenon of dreaming is the same with the blind as with the seeing. It is now generally believed that our dreams are the result of some past association. I believe that all of our dreams may be accounted for in this manner. Some of them appear strange and curious, but it is because we can no longer recall the association or impression, but that impression was once made upon the mind. If this is so, how can the person who has never enjoyed the sense of sight dream of seeing? What conception can a man blind from birth have of a ray of light, of color, or of objects seen at a distance? He might study the subject of the eye for a lifetime but his conception of it would be very obscure. He might learn from physics how images of objects are formed upon the retina, but no amount of study can tell him how an image looked to the eye. How is it possible for him to dream of seeing if he had no concep-

tion whatever of sight? It is the same as if you were to expect a person deaf from infancy to dream of music."

Farsightedness, or hypermetropia. The length of the eyeball plays an important factor in seeing at a distance. When the eyeball is too short to allow the rays of light to fall upon the retina, we have indistinct objects formed on the back of the eye. In hypermetropia the muscle known as the ciliary muscle, compensates in a measure, by allowing the lens to become more convex, which renders the distant object more clear. In youth this function is very pronounced. It recedes as age advances. As we approach middle life it is lost. For this reason one is obliged to use glasses when the forty-fifth milestone is passed. Frequently individuals with very good vision are obliged to wear glasses at forty. When such is the case that man or woman is far-sighted. Race peculiarities, shape of the head has much to do with this form of vision. The Anglo-Saxon races and savage races are far-sighted. Helmbold speaks of the exceedingly acute vision of the Indians of South America. My own examinations among Indians of our own country confirm this. As long as an individual has an out-door occupation, this form of vision plays very little importance in the life work of the person. But when such a person has an in-door occupation, then do a multitude of troubles arise. Among the first to show themselves, is headache. This trouble may take on the most aggravated form, as nausea, pain in and about the eyes, a tired and languid feeling. So well known are these symptoms that an ophthalmic surgeon at once recognizes the trouble, even the family physician, whose advice is frequently sought, at once advises the wearing of glasses properly adjusted. Many individuals after a visit to the opera or an art gallery will return home with a severe headache, and to this form has been affixed the name of "sight-seers" headache. The American who goes "globe-trotting" flies to Paris, visits the numerous picture-galleries, exhibitions, etc., or, as one tourist told me, visits forty-two cities in thirty-two days, and doing all the things set down in the guide book. Let that man be possessed of the least

degree of hyperopia, and he pays for his enterprise by having headache after headache. A pair of glasses would have saved him much misery. Fatigue is also responsible for an important share in its production. The ever changing of the eye whose focus of vision shifts at every turn requires a double effort to give clear vision.

(To be continued.)

A CONTRIBUTION TO METEOROLOGY.

MR. ESPY; DR. HARE; TORNADOES; HAILSTORMS.

By W. P. Tatham.

In the lecture delivered before the FRANKLIN INSTITUTE, Nov. 19, 1888, and published in the JOURNAL for February and March, 1889, Vol. CXXVII, under the title "Some American Contributions to Meteorology," the author characterizes Mr. Espy thus: "Espy was a theorizer."

This is very unfair to Mr. Espy, who, though he had his theories (as every thinking man must have), was eminently an observer rather than a theorizer. Whatever was sound in his theories was based upon observations.

I venture to think that the system of observations, suggested, organized and conducted chiefly by Mr. Espy, while meteorologist of the joint committee of the American Philosophical Society and the FRANKLIN INSTITUTE, was more extensive, both as respects the time devoted to the observations and the area covered by them, than any other which has been recorded, conducted by private effort.

It is not desired to underrate the value of the influence of the two learned societies named, nor, of the services of the members of their joint committee. All of these contributed to the very important published results which led to Espy's appointment as head of the meteorological bureau of the War Department, and afterwards to the organization of the weather service of the United States, upon the introduction of the magnetic telegraph.

It appears, moreover, unfortunate for the learned professor of Harvard to come to the FRANKLIN INSTITUTE and praise Mr. Espy for his theories, wherein he was not always happy, and to dismiss, with a passing allusion, his pre-eminent merits in observation. Here the memory of his enthusiasm and his activity is still preserved, and here we have the original records of his work.

Avoiding the stormy discussions of fifty years ago upon the nature and causes of storms and tornadoes, it will be worth while to consider the phenomena upon which the controversialists agreed, to wit:

(1) A low barometer at the middle of the storm, indicating a low atmospheric pressure.

(2) A general inblowing of the wind towards the middle of the storm, often combined with rotary movement.

(3) An ascending current of air at the middle of the storm, often excessively violent.

Which of these three is first in the chain of causation? and then, what is the cause of this one?

The low atmospheric pressure at the middle of the storm cannot be the first, because it represents a partial vacuum, which would draw the air to it from every direction, vertically as well as horizontally. It cannot cause an ascending current.

A general inblowing of the wind cannot be first, because centripetal winds would cause a *plenum* at the centre and not a *low barometer*.

There remains then, as the first cause among the three, the ascending current of air, occasioned by some influence besides either of the other two phenomena.

An ascending current of air would naturally cause a low barometer beneath it and an inblowing of wind from every lateral direction to re-establish the equilibrium. This is, therefore, the first in the chain.

But what is the cause of this ascending current of air?

I am not aware that any of the writers mentioned in the lecture attempt to account rationally for the ascending current, except by attributing it to the effect of the heat of the sun's rays acting upon a cloud.

These rays penetrate dry air without heating it very much, but they will warm up and expand a cloud, which then will rise, but very slowly.

If any one from an elevation, in the morning, watch the clouds, which have been roosting over night in the valleys, slowly ascend to their places during the day, he will find their ascentional motion so slow as to be scarcely perceptible, so weak is the draft of "the chimney without walls."

Dr. Robert Hare, Professor of Chemistry in the University of Pennsylvania, offered an explanation*, which, though apparently not accepted by the scientific world, is still so consonant with many unexplained phenomena that it would be well to reconsider it.

Referring the reader to Dr. Hare's papers on the subject for a more exact statement of his views, I will briefly repeat the substance of conversations had with him over thirty-five years ago. He said: "There are two familiar experiments in the lecture room, illustrating two different methods of electrical discharge. (1) The electric spark, called the disruptive discharge, and, (2), the pith-ball experiment, which is one method of the convective discharge.

"These are small illustrations of electrical discharges which both occur on a grand scale in nature. Dr. Franklin identified the electric spark with the lightning, and that is conceded. Now a convective discharge on a grand scale in nature takes place when atmospheric air, mingled with the vapor of water, under appropriate electrical conditions, is

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* "On the Causes of the Tornado or Water Spout." By R. Hare, M. D., etc. *Transactions of the American Philosophical Society.* New Series, vol 5, pp. 375–384. Read before the Society April 2, 1836.

Published also in:

Silliman's Journal. Vol. 32, pp. 153–161, July, 1837.
Bibliographie Universelle. xi, pp. 156–159, 1837.
Froriep Notizen. iv, col., 257–259, 1838.
Quetelet. *Corresp. Mathematique.* x, pp. 110–113, 1838.
Sturgeon. *Annals of Electricity.* ii, pp. 195–203, 1838.

See also:

Transactions Am. Phil. Soc. Vol. vi, pp. 297–302, 1839.
Silliman's Journal. xxxviii, pp. 73–86, 1840.
Sturgeon. *Annals of Electricity.* iv, pp. 393–396, 1839–1840.

repelled from the earth and projected upwards with great violence. This is the ascending current of air and vapor in the middle of the tornado. The air rushes in from every direction to restore the equilibrium, and acquires a rotary motion. Here we have an adequate cause for the violence of the tornado, which could never be derived immediately from the heat of the sun. No doubt the sun's heat, acting over large areas, is the cause of the trade winds, but directly it could never produce so local and so violent a disturbance as the tornado."

No doubt an exact analogy between the pith-ball experiment and the alleged convective discharge in nature would require us to provide an upper plate. But convection discharges take place without this in the lecture room.

Dr. Hare's opinions upon this subject were authority with me, but a subsequent observation of my own convinced me completely of the existence of the convective discharge in nature on a grand scale and of its predominating influence on meteorology.

Upon the 30th of April, 1856, I was travelling in the diligence from Florence to Bologna, Italy. We had descended from the hills into the southern margin of the great plain of Lombardy, and at 5 o'clock in the afternoon we were about two hours distant from Bologna. The day had been calm and serene. The sun was declined below the spurs of the Apennines to the west, but his rays illuminated a dense black cloud far to the eastward. The base of this cloud, was below the visible horizon and it seemed to rest upon the earth. It appeared to cover about a mile of the earth's surface and was two or three times as high as broad. There was no appearance of wind motion about the cloud, which was an irregular oblong in apparent shape, resting on the smaller end. My attention was first attracted to the vivid lightning, which was incessantly playing through the cloud.

While watching the lightning, I was amazed to see, suddenly, the middle portion (say about one-fourth) of the side of the cloud towards me projected vertically with incredible velocity, pushing through the whole cloud from base to summit.

It appeared like smoke rushing from the mouth of a cannon, of over a thousand feet calibre, fired vertically.

The lightning ceased immediately. The ascending current in the cloud continued for a considerable time, gradually diminishing in velocity. The motion was distinctly visible, for the moving part of the cloud was shaded differently from the rest, which showed no movement. This different appearance was possibly due to dust or other foreign matter entrained in the movement.

As soon as I could recover myself, I estimated the time occupied by a recognizable portion of the ascending column in moving from the base to the summit of the great cloud, and made it three seconds by my pulse.

Now all these figures are merely estimates. Assuming them to be correct, the upward motion of the column had a velocity of from two-thirds of a mile to one mile per second. The ascending column, as it issued just above the great cloud, seemed to have passed its goal and lost its volume and velocity. What was left of it was much lighter in color and fleecy in appearance. It floated off lazily in fragments to the right and left, and when clear of the great cloud it rapidly descended towards the earth, and then moved towards the base of the great cloud and joined to it. This indicated an outblowing current of air above, and an inblowing below.

Upon arrival at Bologna, while the baggage was being examined, I stepped outside the gates to take a last view of the scene of the late storm. The great cloud was scattered, the higher portions reflecting the rays of the sun, now set. There was an icy-cold wind blowing *from* the direction of the late disturbance.

When I arrived at the hotel I called the landlord, and told him I wanted to go the next day to a place about fifteen miles southeast of Bologna, where I had observed an electrical storm of a peculiar character about three hours before. He told me that the next day was market day, that he had many customers living in that direction, and that if I only wanted to know the character of the storm he could probably get the information from some of them, and he

promised to make inquiries. I assented and waited. The next day, after a tour of sight-seeing, I returned to the hotel and asked my landlord if he had made the inquiries he had promised. He answered that there was no necessity for asking questions. All the men who came in from that district were full of their accounts of the greatest *hailstorm* they ever saw, and could talk of nothing else.

I have said that the eruption appeared at the middle of the western side of the cloud presented to me. Had it taken place within the cloud, I could not have seen anything except the slight disturbance over the summit, such as has been observed before, and attributed to a violent ascending current. The rays of the sun must have warmed the western face of the cloud and caused some circulation, but this would appear to have had only a similar relation to the great uprising, as the burning of the fuse of a cannon has to the subsequent explosion.

The *rationale* of this hailstorm seems to be very simple. The vapor projected upwards to above the snow line, condensed and froze to small hailstones, which would be impelled to fall by gravity, but could not fall against the current. They were kept dancing upon the vertical blast, growing larger all the time, until some of them would be jostled overboard, or, until the cessation of the blast permitted them to fall *en masse*.

But why did not the summit of the great cloud (assumed to be above the snow line) condense before the great upblast from the lower part? Perhaps portions of it did, for the lightning was brilliant and frequent.

The experiments of Dufour* may throw light upon the subject.

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* *Bibliographie Universelle*, 1861. *Annales de Chim. et de Phys.*, iii, 68, pp. 370-393.

Dufour says, with philosophical caution: "Il me parait hors de doute que la chaleur seule, agissant sur ce corps sans le concours d'actions moleculaires étrangères, ne peut pas produire son changement d'etat que bien au dessus de la temperature envisagée comme celle de l'ebullition normale."

And also:

"Les retards d'ebullition sont manifestment du même genre que les retards de solidification."

In the experiment upon the feezing of water floating in a suitable bath of oil, which was gradually cooled, he found that the larger globules were generally the first to freeze, the smaller ones remained fluid longer, and some of them of one millimetre diameter survived in a liquid state until the temperature of the bath was reduced to —20° C. A larger globule, frozen at —1° to —2°, being pushed against a globule of water, the water would flow around and envelop the frozen globule and freeze over it, and this could be repeated over and over again, thus imitating artificially the concentric layers of a hailstone.

Operating in the same way upon water within a bath of oil, which was gradually heated up, he found, as a rule, that the larger globules first became steam, while the smaller remained as water, and some globules of from one to three millimetres diameter, remained liquid until the bath was heated to 175° to 178° C. under atmospheric pressure. Steam at this temperature has an elastic force of eight or nine atmospheres.

A light galvanic current passed through a globule always and immediately caused it to become vapor.

The conditions under which Dufour obtained his extreme results were: (1) Very small globules of water; (2) quiet; (3) absence of contact with solid bodies, and (4) electrical insulation. All of these conditions probably existed at the summit of the cloud, the size of the globules of water in the cloud being very much less. It is, therefore, reasonable to suppose that condensation and freezing there could not have taken place even at an extremely low temperature. Dufour reports no experiments upon cloud, but the mutual repulsion among the particles of a highly electrified cloud would alone probably delay aggregation.

The violent projection of the lower part of the cloud, charged with the electricity of the earth and conveying solid matter to the cold regions above, would destroy all the conditions of delay and occasion immediate condensation and freezing.

It would appear from the foregoing considerations that the difficulties which Pouillet has presented in understanding

hailstorms have disappeared in this case.* He says: "To explain hail, there are only two difficulties, but they are very great, and we can say in advance that they remain above all the efforts which have been made to resolve them.

"In the first place, the thing is to know how the cold is produced which freezes the water, and then, how is it that a hailstone which has acquired size enough to fall by its own weight rests still suspended in the air during all the time which is necessary for it to arrive at a volume of from twenty to thirty centimetres of circumference (eight to twelve inches)."

I am not aware that any account of an ascending current of such velocity and violence as that described, has ever been published. Generally the existence and character of such currents have been proved only by their disastrous results. Such proofs, however, are innumerable and overwhelming. The ninth edition of the *Encyclopædia Britannica* contains, for instance, a description of a storm at Mt. Carmel, Ill., June 4, 1877, by which the Methodist Church steeple, with its ball and vane, was carried off bodily through the air fifteen miles to the northeast. The ascensional force exhibited in this and many other instances must have required an incredible vertical velocity of wind.

Let us suppose a great cloud (which is no better conductor of electricity then dry air) highly charged with, say, positive electricity, to be floating in an atmosphere similarly electrified and resting over a portion of the earth's surface largely charged with negative electricity by induction. The cloud would be attracted until it touched the surface of the earth, already warmed by the sun. The particles of cloud in contact, after acquiring a negative charge, would be repelled from the earth to the lower surface of the positive cloud, where they would join to and neutralize a similar quantity of cloud and both be repelled to and from the cloud and the earth alternately, increasing in volume and range until the character of the convection should change

* Pouillet. *Elements de Physique et de Meteorologie. De la grêle, etc., liv, viii.*

to a dark glow of immense proportions accompanied by a violent wind, terminating as seen.

If these violent vertical currents are not occasioned by convectional discharges of electricity, as Dr. Hare supposed them to be, what are the causes of them? Their existence is certain, and indeed it is probable, that they frequently occur, not with violence and destruction, but with gentle action and beneficent effects upon the temperature of the lower atmosphere. We shall have to classify them and give them Greek names and call it "science," according to the rule of the old peripatetic: "*Qu'il faut bien citer ce qu'on ne comprend point de tout dans la langue qu'on entends le moins.*"

THE DIFFRACTION OF SOUND.

BY W. LE CONTE STEVENS.

[*Abstract of a Lecture delivered before the* FRANKLIN INSTITUTE, *February 18, 1889.*]

The conception that sound is due to wave motion in an elastic material medium seems to have been entertained before the beginning of the seventeenth century by Lord Bacon. To Sir Isaac Newton, however, is due the credit of formulating it distinctly, and establishing it firmly on a mathematical basis. The application of the same theory to light was most natural, but Newton's clear understanding of certain necessary consequences, which, to his mind, did not seem to be realized in the case of light, caused him to reject the wave theory and to substitute for it his well-known emission theory, which for more than a century held undisputed sway. The phenomena of diffraction, which constituted Newton's stumbling-block, became afterward the strongest evidence in favor of the wave theory of light as developed by Young and Fresnel. The elementary experiments had been repeated by Grimaldi, Hooke, Huygens and Newton, but the true explanation of them did not occur to a single one of these acute observers. Waves of

light were not too short for Newton to measure, but instead of regarding them as waves, he measured what he took to be the intervals between "fits" of reflection and of transmission.

If we admit the fundamental principles of the wave theory as developed by Huygens, it follows as a necessary consequence that diffraction must occur at the edges of any obstacle interposed in the path of a wave front, or at the edges of one or more openings through which the waves are propagated. With a view to application, it may be advisable to give briefly the deduction of the formula for interference by waves diffracted at the edges of small openings.

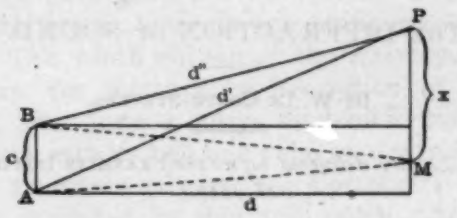


FIG. 1.

Let A and B be edges of a pair of contiguous minute openings through which waves are propagated in the same phase; they become centres therefore of new systems of secondary waves. Let AM and BM be the sides of an isosceles triangle with AB as base. Then M is a point where like phases meet, a point of maximum motion; of brightness if the waves be those of light, of noise if they be those of sound. Through M let a plane be passed perpendicularly across the original direction of propagation, and let P be any point of it. For brevity the distance from A or B to this plane may be called d; from A to P, d'; from B to P, d''; from A to B, c; from M to P, x, and the wave length, λ. Then, if $d' - d'' = \lambda$, or $d' - d'' = n\lambda$, n being any integer, P is a point where like phases meet, and therefore a point of motion. If $d' - d'' = \frac{1}{2}\lambda$, or $d' - d'' = \frac{1}{2}n\lambda$, P is a point where opposite phases meet, and therefore one

of quiescence. To find the distance, x, between two successive points of maximum motion, we have

$$d'^2 = d^2 + (x + \tfrac{1}{2}\, c)^2$$

$$d''^2 = d^2 + (x - \tfrac{1}{2}\, c)^2$$

Extracting the square root and discarding powers of c, since this is small in comparison with d, as is x also, we have, approximately,

$$d' = d + \frac{(x + \frac{1}{2}\, c)^2}{2\, d}$$

$$d'' = d + \frac{(x - \frac{1}{2}\, c)^2}{2\, d}$$

whence,

$$d' - d'' = \frac{c}{d}\, x$$

but

$$d' - d'' = \lambda$$

hence,

$$x = \frac{d}{c}\, \lambda$$

From this well-known formula it is seen that $x \propto \lambda$. If c be the element of a diffraction grating for light, and d be the distance from grating to screen, x is at once determined if λ be known. Assuming a coarse transmission grating in which $c = \frac{1}{1250}$ inch, taking λ for red light $= \frac{1}{40000}$ inch, and $d = 300$ inches, we have the value of x a little over nine inches.

Now assuming the waves to be those of sound, the pitch being that of a high soprano tone, 1,024 vibrations per second, if diffraction could be produced and measured from such a grating, the corresponding value of x would be not far from eighty miles. Increasing the element of the grating to an inch, x is reduced to about 10 drayos. It is obvious, therefore, that the diffraction of sound waves is, under ordinary conditions, so great as to defeat all efforts directed toward its actual measurement or even qualitative demonstration. Sound shadows, instead of being nearly geometric like those of light, are usually too ill-defined to be traceable at all, if the propagation is through air.

In 1826, Colladon's classic experiments were made in the Lake of Geneva for the determination of the velocity of sound in water. Incidentally he noticed quite well-defined sound shadows behind the edge of a stone wall projecting into the lake. A peculiar phenomenon, which was observed but not explained by him, was that the sound of the distant bell reached the membrane of the submerged hearing trumpet as a sharp click, without definite musical character. This was due to the quick and violent initial stroke of the hammer upon the bell, while the energy of the slower vibrations, due to the bell's elasticity, was absorbed by the aqueous medium.

In 1874, much more remarkable experiments on the production of sound shadows in water were made in the Bay of San Francisco, by Prof. John Le Conte and his son, Mr. Julian Le Conte. In the process of deepening the harbor, dynamite was used for the purpose of blasting away a submerged reef of sandstone. Glass bottles hung in the water were shattered by the impulse propagated through the elastic medium from a distance of forty feet, but perfectly protected if placed within the geometric shadow of a pile. When the cartridge was aligned with two piles twelve feet apart, forty feet from the nearer one, the well-defined shadow of the first pile covered the second one, so that bottles placed anywhere between the two were protected. Thick glass tubes, placed across the shadow, were shattered in all parts exposed beyond it, and protected in the middle parts that were within it.

To account for the comparative absence of diffractive effects in these experiments it is necessary to assume that the waves were exceedingly short. It was pointed out by Dr. Le Conte that a sufficient cause for this is found in the instantaneous character of the dynamite explosion. The wave length is equal to the product of the velocity of propagation and the time consumed in generating the wave. This form of statement is only a modification of the familiar formula,

$$\lambda = \frac{v}{n}$$

since the time of a single vibration and the number of

vibrations per second bear a reciprocal relation. The quickness of action manifested in the explosion of dynamite is such that the duration of the generating impulse is almost infinitesimal. Assuming it to be a millionth of a second, and taking $v = 4{,}700$ feet for water, the resulting wave length would be only about one-seventeenth of an inch.

In 1880, the explosion of a dynamite factory near the University of California resulted in the production of two sounds at a distance, one conducted by the ground, the other by the air. The university building cast an acoustic shadow, at least three hundred yards long, within which the aërial impulse was imperceptible. The velocity of sound in air being less than a fourth of that in water, the wave length under similar conditions must be correspondingly short.

Prior to the dynamite explosion just mentioned, Lord Rayleigh, in England, had achieved some remarkable results in diffraction of sound, without resorting to so dangerous a source as an explosive. A whistle of very high pitch was employed as a producer of sound. The difficulty in using it consists in the fact that when the intensity is very slight a high pitch becomes inaudible. Something else than the human ear has to be used, therefore, as an appreciator or indicator. Dr. Le Conte discovered in 1857 that, under appropriate conditions, a common gas flame is delicately sensitive to sound. In the hands of Barrett and Tyndall the sensitive flame was improved; and Lord Rayleigh has employed it in exploring the regions of the air, where, according to theory, sound shadows ought to be produced when short waves are propagated from a source, such as the whistle just described. I have repeated successfully all the experiments described by Lord Rayleigh, many of which have been but recently devised, and I have used the sensitive flame in establishing still further analogies between light and sound.

The value of a good sensitive flame may be illustrated in a variety of ways. In producing it the cylindrical steatite burner is best fitted into the end of a metal pipe, which is connected by rubber tubing with a cylinder of compressed coal gas. From this the supply of gas is care-

fully regulated with the aid of a water manometer gauge. A good burner gives a tall quiet flame, twenty inches or more in height, which does not begin to flare until the pressure is in the neighborhood of ten inches of water. When just ready to flare, but still quiescent, such a flame indicates very beautifully the ticking of a watch held near it, every tick producing a momentary disturbance of the flame which is visible across a large audience room. It is, moreover, unequally sensitive in two directions at right angles to each other, as first pointed out by Lord Rayleigh. If the pressure be adjusted so that the flame just flares when its sensitive side is turned toward the high pitched whistle, it will cease to flare when turned round on its own axis through a right angle, so that its "deaf" side is toward the whistle. Let a mirror now be placed a foot away on the sensitive side, and equally inclined to flame and whistle. The flaring is at once renewed, but ceases the moment the angle of incidence is changed by rotating the mirror slightly about a vertical axis. Restoring the flame so that its sensitive side is again toward the whistle, if the mirror is put on the further side squarely across the line of direction of the whistle, the flame is seen alternately to flare and become quiescent according to the distance at which the mirror is held. Reflected waves meet advancing waves, producing loops and nodes. If the mirror is at such a distance that the flame is in a loop, it flares with much violence; if in a node, it becomes quiescent. Lord Rayleigh made the remarkable observation that the effect on the ear is just the reverse. The sound seems most intense when the ear is at a node rather than a loop. A convenient method is at once suggested for measuring the pitch of the whistle, even though the note it yields may be too faint and too high to be distinctly audible. By carefully measuring the distance between two successive positions of the mirror which cause the flame to be in a node, the half-wave length is obtained. The pitch thus becomes known from the formula,

$$n = \frac{v}{\lambda}$$

where v is the known velocity of sound, and n is the number

of double vibrations per second. For these experiments the whistle should yield from 12,000 to 24,000 as its pitch.

The most interesting application of the sensitive flame is in relation to the phenomena of sound shadows and diffraction. The whistle may be held in a fixed position, and supplied with a constant blast by connecting it with a cylinder of compressed air, the supply being regulated with a water manometer gauge. When the sensitiveness of the flame is so adjusted that it flares distinctly though not very violently, the interposition of the hand is enough to restore it to quiescence by protecting it with a sound shadow. A circular disk of card-board may be substituted for the hand. In one position it may serve as a protector. In another it may cause the flame to flare as strongly as if no obstacle existed. This is caused by the meeting of waves diffracted at the edges of the disk so as to meet at a point behind the middle of this. The experiment was first performed by Lord Rayleigh about 1878; it is the acoustic analogue of the celebrated experiment in diffraction of light, skeptically suggested by Poisson and performed by Arago immediately after the French Academy had received Poisson's adverse criticism of Fresnel's paper on diffraction, written in 1819.

This principle is conveniently applied to the construction of a diffraction grating for sound, such as was first made by Lord Rayleigh. Let A (*Fig. 2*) be the radiant point, the mouth of the whistle. Let B be the sensitive point, the opening of the steatite burner at the end of the nozzle. Let a plane be passed perpendicularly across the line AB at some point, O. Every point in this plane may, according to Huygens' principle, be regarded as a diffractive centre from which secondary waves are sent forth. Let P be one of these points so selected that the sum of the distances AP and PB shall exceed AB by a half wave length; or using symbolic notation,

$$(a' + b') - (a + b) = \tfrac{1}{2}\lambda \qquad (1)$$

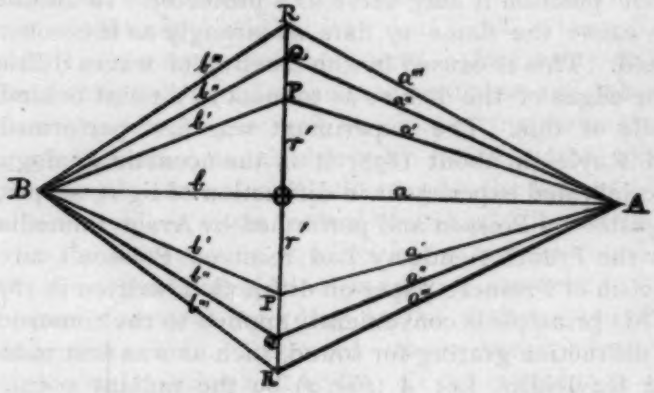
Then the diffractive effect of P is to produce at B complete interference with waves proceeding from A directly to B.

In like manner there exist other points, *Q*, *R*, etc., so placed that

$$(a'' + b'') - (a + b) = \tfrac{3}{2}\lambda \qquad (2)$$

$$(a''' + b''') - (a + b) = \tfrac{4}{2}\lambda, \text{ etc.} \qquad (3)$$

From this it is seen that if *OP*, *OQ*, *OR*, etc., be taken as radii, and circumferences be drawn in the transverse plane, we will have a central circle and concentric rings around it so related that for every point in the circle whose radius is *OP* there is a point in the adjacent ring whose width is *PQ*, the effect of which is to produce complete interference; and one in the alternate ring whose width is *QR*, the effect of which is to produce complete accordance.



$OP = r'$; $OQ = r''$; $OR = r'''$; λ = wave length.

FIG. 2.

Let the radii *OP*, *OQ*, *OR*, etc., be called r', r'', r''', etc. Then

$$a'^2 = a^2 + r'^2, \therefore a' = (a^2 + r'^2)^{\frac{1}{2}} \qquad (4)$$

$$b'^2 = b^2 + r'^2, \therefore b' = (b^2 + r'^2)^{\frac{1}{2}} \qquad (5)$$

Expanding (4) and (5) by the binominal theorem, and rejecting all after the second term, since r' is small in comparison with a or b, we have, approximately,

$$a' = a + \frac{r'}{2a}$$

$$b' = b + \frac{r'}{2b}$$

In like manner,

$$a'' = a + \frac{r''}{2a}$$

$$b'' = b + \frac{r''}{2b}, \text{ etc.}$$

Substituting these values of a' and b' in equation (1), also of a'' and b'' in equation (2), etc., and reducing, we have

$$r'^2 = \frac{ab}{a+b}\lambda$$

$$r''^2 = \frac{ab}{a+b}2\lambda$$

$$r'''^2 = \frac{ab}{a+b}3\lambda$$

Or, if n represent the order of any zone whatever,

$$r_n^2 = \frac{ab}{a+b}n\lambda$$

If the position of the plane of zones be midway between A and B, this formula becomes

$$r_n^2 = \tfrac{1}{2}an\lambda$$

The value of λ for any given whistle having been determined by the method of stationary waves just described, and that of a being selected at will, the successive values of r are found, and the corresponding circles drawn on cardboard or zinc. Leaving the central circle intact, the first, third, fifth, etc., rings are cut out. The diffractive effects of all the remaining alternate zones are therefore conjoined, and a flame at B flares now far more violently when the whistle is sounded than if no obstacle had been interposed. If the grating be slightly lifted so as to throw the axial line AB above the nozzle of the burner, the flame becomes quiescent. It was previously in a region of noise; it is now in a ring of silence that surrounds it. Lifting the grating a little higher, the flame flares again slightly; it is in a ring of noise. This is roughly shown in *Fig. 3*, which is an amplification of the left half of *Fig. 2*. It is seen that there are other points, C, D, etc., at which sound rays from the

diffractive centres *P*, *Q*, *R*, etc., may meet, though the conjoint effect may not be so strong as at *B*. The locus of *C* is obviously a circle around *B* as centre. The relative intensities of disturbance are shown by the black areas, as determined by the German physicist, Lommel. I have at times succeeded in tracing out four or five of these successive rings of noise and silence by the aid of the sensitive flame.

When light is transmitted through a pair of adjacent small apertures, diffraction fringes are produced. According to theory, as shown by Young and Fresnel, the locus of

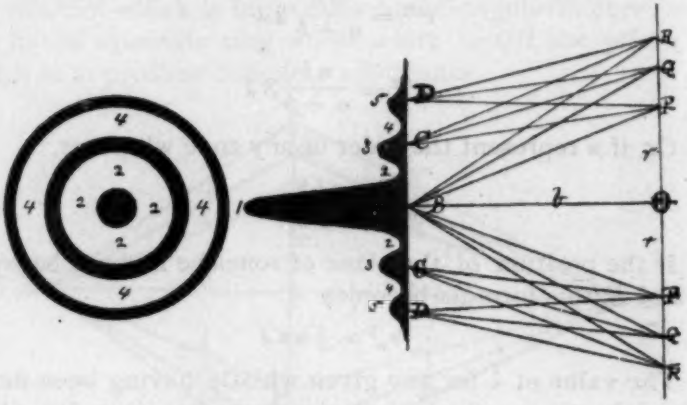


FIG. 3.

At 1, 3 and 5, meeting of like phases.
At 2 and 4, etc., meeting of unlike phases.
1, central area of noise; 2 and 4, first two rings of silence; 3 and 5, first two rings of noise.

interference in space between aperture and screen is a hyperbola. By very delicate micrometric measurements Fresnel found the results of experiment to justify the prevision of theory. I have applied the sensitive flame in exploring for these hyperbolas when short sound waves were transmitted through a pair of openings in a screen of cardboard. The whistle, whose pitch was about 13,000, sent forth waves, therefore, of about 1·05 inch in length. It was placed thirty-four inches from the screen, whose width was two feet. Near the middle of this were cut two vertical

slits, three inches apart and one-quarter inch wide. The screen being at right angles to the line of direction of the whistle, and this line passing midway between the two slits, the position required by theory for the hyperbolic bands was determined. There was no difficulty in detecting the middle line of maximum motion behind the screen. The nearest hyperbolas on the two sides of this were then found and traced back about a foot. The definition of these was inferior to that of the middle line, as might naturally be expected. The next pair of hyperbolas was also found, but with poor definition.

Perhaps the most important experiment employed by Fresnel in the establishment of the wave theory of light was that of producing interference bands, independently of all diffracting edges, by reflecting the light from a pair

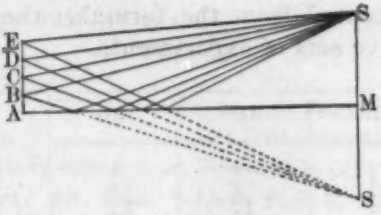


FIG. 4.

of mirrors making with each other an angle of very nearly 180°. The acoustic analogue of this has been performed by Prof. A. M. Mayer and myself together. Six interference bands were detected by means of the sensitive flame. Their distance apart was measured, and the result was found to accord very closely with that demanded by theory. On account of the trouble resulting from waves proceeding directly from the source of sound, or diffracted around the edges of a screen interposed to cut them off, this method of experiment was abandoned. A modification of the experiment was repeatedly tried by me, and with quite uniformly satisfactory results. A single mirror was placed horizontally on the table, so that waves reflected from it might interfere with those proceeding directly from whistle to flame. The effect of the reflected waves was the same as

if they had come from a virtual source, S' (*Fig. 4*), and the theory becomes then the same practically as that given on a previous page for the diffraction grating for light. Knowing λ, AM, and SM, and the distances AB, AC, AD, etc., at B, C, D, etc., there is complete accordance; or, the distance of the points of complete interference may be measured and the results of experiment compared with those of theory.

In the following table the results of some experiments are given. The height, MS, of whistle above table is ten inches; the distance AM, thirty-six inches; the wave length λ, 1·05 inch. Then

$$AB = \frac{AM}{SS'}\lambda$$

The successive measurements are of distances above the table at which the flame became quiescent. The first column is calculated from the formula; the others are the records from five sets of experiments.

Theory.	I.	II.	III.	IV.	V.
·945	·9	1·0	·9	1·0	1·0
2·835	2·8	2·7	2·7	2·8	2·9
4·725	4·7	4·6	4·7	4·9	4·7
6·615	6·7	6·7	6·7	6·9	6·7
8·505	8·9	9·0	8·8	9·0	9·1
10·395	11·0	11·3	11·0	11·2	11·3
12·285	—	13·6	—	13·6	13·6

These results are sufficient to show that the sensitive flame makes it possible to exhibit before large audiences the demonstration of principles hitherto accepted as the result of calculation, or verified only by individual experiment. If not applicable for purposes of refined and exact measurement, it comes nearer to the fulfilment of these conditions than any other means that has hitherto been applied for these purposes in acoustics.

PROCEEDINGS

OF THE

CHEMICAL SECTION,

OF THE

FRANKLIN INSTITUTE.

[*Stated Meeting, held at the* INSTITUTE, *Tuesday, May 21, 1889.*]

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, May 21, 1889.

Mr. H. PEMBERTON, Jr., President, in the Chair.

Members present: Mr. Chas. Bullock, Prof. R. L. Chase, Dr. W. C. Day, Mr. Lee K. Frankel, Dr. Wm. H. Greene, Mr. Reuben Haines, Dr. L. B. Hall, Dr. S. C. Hooker, Mr. Fred. E. Ives, Dr. H. W. Jayne, Dr. H. F. Keller, Mr. T. C. Palmer, Mr. W. L. Rowland, Prof. S. P. Sadtler, Dr. E. F. Smith, Prof. Henry Trimble, Dr. Wm. H. Wahl.

Dr. Greene called the attention of the Section to the fact that efforts are now being made by the American Association for the Advancement of Science to form a National Chemical Society, with headquarters in Washington, and which shall hold regular annual meetings. He further stated that he had been requested by a member of the American Association to bring the matter before the Chemical Section of the INSTITUTE, with the object of securing the nomination of delegates to represent the Section in the matter at a meeting to be held at the same time and place with that of the American Association, to be held during the coming summer.

After some discussion by the President and Drs. Hall, Wahl and Greene, on motion of Dr. Greene, it was voted that the President appoint a committee to investigate the matter more fully, and report to the Section at its next meeting. The President appointed Drs. Greene, Hall and Wahl members of this committee.

Professor Sadtler then read a paper, "On the Presence of Paraffine in Crude Petroleum," which was referred for publication.

Mr. Charles Bullock read a paper "On the Preparation and Properties of Pure Metallic Manganese." He also exhibited two specimens of metallic manganese; one of them had been obtained by reducing chloride of manganese by means of sodium, using fluor spar alone as the flux, and the other by using chloride of sodium without fluor spar. The paper was referred for publication.

Dr. Keller followed with a paper "On Kobellite from Colorado, and the Chemical Composition of this Mineral;" also, "An Analysis of Megabasite." Some very fine specimens of the minerals were exhibited by Dr. Keller. The paper was submitted for publication.

Dr. Hooker then read his report "On the Philadelphia Water Supply" for the past month. Aside from the muddiness of the water, the report was favorable to the present condition of the supply. The report was submitted for publication.

A paper "On the Electrolytic Separation of Cadmium from Zinc," by Dr. Smith and Mr. Frankel, was next read by Dr. Smith. It was submitted for publication.

Dr. Smith also read a paper entitled, "Derivatives Obtained from Mono-Chlor-Dinitro-Phenol and Bases of the Aromatic Series."

This paper is preliminary to an investigation now going on. It was referred for publication.

Dr. Greene then followed with recent results obtained by him and Dr. Hooker in their investigation of lapachic acid and its derivatives.

Upon recommendation of the President and motion of Mr. Palmer, it was voted that the notification of members of the meetings of the Section be attended to, under the direction of Dr. Wahl, by one of the clerical force of the INSTITUTE.

Adjourned.

WM. C. DAY, *Secretary.*

A RAPID COLORIMETRIC METHOD OF DETERMINING NITRATES IN POTABLE WATERS.*

By Samuel C. Hooker, Ph.D.

[*Read at the Stated Meeting of the Chemical Section of the* Franklin Institute, *March 19, 1889.*]

In devising a process for the estimation of nitrates in the minute quantities in which they occur in natural waters, I have not been ignorant of the fact that there are already several very satisfactory ways in which this can be accurately done. I have, however, aimed at greater rapidity than has heretofore been possible.

Fully fifteen years ago Graebe and Glaser discovered carbazol, and observed that when dissolved in concentrated sulphuric acid it gave rise to an intensely green solution on the addition of nitric acid. This reaction, which up to the present time has been used only as a means of identifying carbazol, forms the basis of the process to be described. Its extraordinary delicacy renders it particularly suitable for the purposes of water analysis, and enables a quantity of nitric acid, containing as little as $\frac{6}{10.000}$ of a milligramme of N to be accurately determined. The reaction is not, however, peculiar to nitric acid; all oxidizing agents behave similarly. Graebe and Glaser enumerate chlorine, bromine, iodine, nitrous and chromic acids as giving rise to the same intensely colored solution. With the exception of nitrous acid, the substances just mentioned are almost invariably absent from natural waters, and may therefore be dismissed from further consideration. There is, however, one other oxidizing agent, namely iron in the ferric condition, which is sometimes found in very appreciable quantities, and it therefore became necessary, in studying the influence of the substances in solution upon the process, to give special attention to iron as well as to nitrous acid.

* See preliminary paper, Journal of the Franklin Institute, **127**, 16.

As the result of a number of careful experiments, the following conclusions were arrived at with regard to the application of the process:

(1) No material error will arise in the presence of nitrites in the quantities in which they usually occur.

(2) Iron (in the ferrous or ferric condition), if present in quantities greater than 0·1 parts per 100,000, must be removed.

(3) Chlorides, even when present in very small quantities, must be removed.

(4) Carbonate of lime, sulphates of lime, soda, etc., in the quantities in which they ordinarily occur, were not found to influence the determinations.

(5) The presence of easily destructible organic matter, such as albumen, lowers the result, not materially, however, unless present in large excess.

The estimation, briefly described, is made as follows:

Two cubic centimetres of the water to be examined is mixed with 4 cc. concentrated sulphuric acid; the mixture is cooled and a small quantity of carbazol, dissolved in sulphuric acid, added. If nitric acid be present, the solution will turn green on the addition of the carbazol, and the intensity of the color, by comparison with that produced by solutions of potassic nitrate of known strength, will, within certain limits, indicate the amount of the acid present.

The great majority of waters can be estimated directly without previous concentration, and only a few will need to be diluted. The limits within which the determinations may be safely made are marked by quantities of nitric acid representing ·03 and ·40 parts N per 100,000. Water containing either less or more nitric acid than indicated by these figures must be concentrated or diluted.

To test the accuracy of the process, a number of solutions were prepared, at my request, containing different quantities of potassic nitrate. In order that my judgment might not be influenced by a knowledge of the amount of nitric acid present, I was kept in ignorance of the strength of the solutions until after the estimations had been completed.

The following are the results obtained:

NITRIC ACID EXPRESSED AS N IN PARTS PER 100,000.

Present.	*Found.*	*Error.*
·127	·130	+ ·003
·078	·075	— ·003
·200	·190	— ·010
·302	·300	— ·002
·290	·290	·000
Average error, ...		·0036

NITRIC ACID PRESENT IN THE 2 CC. OF WATER OPERATED UPON EXPRESSED IN DECIMALS OF A GRAMME.

Present.	*Found.*	*Error.*
·00001143	·00001170	·00000027
·00000702	·00000675	·00000027
·00001800	·00001710	·00000090
·00002718	·00002700	·00000018
·00002610	·00002610	·00000000
Average error, ...		·000000324

The above results are not selected, but include all the determinations that have been made with solutions of unknown strength, with the object of testing the delicacy of the process. It is to be borne in mind, that potassic nitrate *only* was present. Considering the extremely minute quantities operated upon, the accuracy of the above results is very noteworthy.

The following reagents are required:

(1) Concentrated sulphuric acid.
(2) An acetic acid solution of carbazol.
(3) A sulphuric acid solution of carbazol.
(4) Standard solutions of potassic nitrate.
(5) A solution of aluminic sulphate.
(6) A standard solution of sulphate of silver.

(1) The sulphuric acid, used for all purposes in the process, should be almost entirely free from oxides of nitrogen. It may be readily tested by dissolving in it a small quantity of carbazol. If the solution be at first golden yellow or brown, the acid is sufficiently pure; if it be green or greenish, another and better sample must be taken. It is essential also that the specific gravity of the acid be fully 1·84,

and it is well to ascertain that this is really the case, as I have found several samples, obtained from sources which are generally thought reliable, to fall considerably below these figures. The acid was in fact worthless for the purpose required.

(2) The carbazol used was obtained from Kahlbaum,* of Berlin. The acetic acid solution is prepared by dissolving 0·6 gramme in about 90 cc. of 99–100 per cent. acetic acid, by the aid of gentle heat. It is allowed to cool and is then made up to 100 cc. by the further addition of acetic acid. The exact strength of this solution is of no material importance to the success of the process, and the above proportions have been selected principally because they are convenient. The solution will probably remain unchanged almost indefinitely; but I cannot speak positively in this respect, as my actual experience extends only over a period of several months. The use of this solution merely facilitates the preparation of that next described, which will not keep, and has consequently to be freshly prepared for each series of determinations.

(3) The sulphuric acid solution of carbazol is easily made in a few seconds, but it is advisable to allow it to stand from one and one-half to two hours before using. It is prepared by rapidly adding 15 cc. of sulphuric acid to 1 cc. of the above described acetic-acid solution. This quantity usually suffices in my hands for from two to three nitrate estimations. When freshly prepared it is golden yellow or brown; it changes gradually, however, and in the course of one and one-half or two hours it becomes olive-green. I am not able to say positively to what this change is due, but it seems probable that traces of oxidizing agents occur in the sulphuric and acetic acids, and that these, although not present in sufficient quantity to act immediately, gradually bring about the reaction described. The greenish color does not interfere with the process, as might at first be supposed; on the contrary, I have observed that the solution is not sensitive to small quantities of nitric acid until

* Kahlbaum's carbazol may be obtained from James W. Queen & Co., Philadelphia.

it has undergone the change to olive-green, and it is for this reason that I have advised that it should be prepared about two hours before required for use. This solution may be thoroughly depended on for six hours after preparation. The intensities of color produced by the more concentrated solutions of nitrates after this time, gradually approach to each other and become ultimately the same.

(4) The standard solutions of potassic nitrate are very readily prepared. The solutions which are to be compared directly with the waters examined, may be prepared as required, but if many determinations are to be made with a variety of waters, it will be found best to prepare a complete series, differing from each other by ·02 parts N in 100,000. This series may include solutions containing quantities of nitrogen in 100,000 parts, represented by all the odd numbers from ·03 up to ·39. It will be found convenient to prepare them in quantities of 100 cc. at a time, from a stock solution of potassic nitrate (b), which contains ·00001 gramme N, or ·000045 HNO_3 in 1 cc. Each cubic centimetre of this solution, when diluted to 100 cc., represents ·01 N in 100,000, and consequently if it is desired to make a solution containing ·35 parts N in 100,000, 35 cc. are taken and made up to 100 cc., and so on. The solution of potassic nitrate (b) is best prepared from a stronger one (a), containing ·0001 gramme N to the cubic centimetre, or ·7214 gramme KNO_3 to the litre: 100 cc. of (a) made up to one litre, gives the solution (b). It is obvious that the series of solutions above described could be made directly from (a), but by first making (b) greater accuracy is secured.

(5) For purposes which will be presently described, a solution of aluminic sulphate is required, containing five grammes to the litre. The salt used must be free from chlorine and iron; and the solution should give no reaction when tested, as in the case of a water with carbazol.

(6) The standard solution of sulphate of silver is required for the removal of chlorine from the water to be examined. It is prepared by dissolving 4·3943 grammes of the salt in pure distilled water and making up to one litre. The sul-

phate is preferably obtained by dissolving metallic silver in pure sulphuric acid. The solution should be tested with carbazol in the same way as will be presently described for water; if perfectly pure no reaction will be obtained. As sulphate of silver is often prepared by precipitation from the nitrate, it is very apt to contain nitric acid, and consequently if the source of the salt be not known, this test should on no account be omitted.

Having described the preparation of the reagents, the method of making the determinations may now be considered more in detail. Assuming the water to be free from all substances capable of affecting the accuracy of the results, the process is carried out as follows: Two cubic centimetres of the water is carefully delivered by means of a 2 cc. pipette into the bottom of a test tube; 4 cc. of sulphuric acid is added, and the solution thoroughly mixed by the help of a glass rod. The test tube is then immersed in cold water, and when well-cooled 1 cc. of the sulphuric acid solution of carbazol is added, and the whole again mixed as before. The intensity of the color is now observed, and a little experience enables a fairly good opinion to be formed of the quantity of nitric acid present. Suppose that the water is roughly estimated to contain about ·15 parts N per 100,000, solutions of potassic nitrate, containing ·11, ·15, ·19 parts N, are selected from the series. Two cubic centimetres are taken from each and treated side by side with a fresh quantity of the water, precisely as described for the preliminary experiment, the various operations being performed as nearly simultaneously as possible with each of the samples, and under precisely similar conditions. Two or three minutes after the carbazol has been added, the intensity of the color of each is observed. If that given by the water is matched by any of the standard solutions, the estimation is at an end. Similarly, if it falls between two of these, the mean may be taken as representing the N present in cases in which great accuracy is not required. If this be done, the maximum error will be ·02 N or ·09 parts HNO_3 per 100,000. If greater exactness be required, or it be found that the color given by the water is either darker or lighter than that given by all

the standard solutions, a new trial must be made. In such a case the water must be again tested simultaneously with the solutions with which it is to be compared. This is rendered principally necessary for the reason that the shade of the solutions to which the carbazol has been added is apt to change on standing. Hence, it is desirable that the water, and the standard potassic nitrate with which it is to be compared, should have the carbazol added at as nearly the same time as possible. When finally the color falls between that given by any two consecutive members of the standard potassic nitrate series, the estimation may be considered at an end, and the mean of these solutions taken as representing the N present. The maximum error in this case will be only ·01 N per 100,000 parts, and the mean error slightly more than ·005. This degree of accuracy is believed by the author to be quite sufficient for, if indeed it does not exceed the needs of, all ordinary cases of water analysis for sanitary purposes, for which the process was specially devised. If occasionally, however, greater accuracy is desirable, the determinations recorded in the early portion of this paper show that the average error can be reduced to ·0036 parts N per 100,000. In this case the standard solutions employed must differ from each other by ·01 parts N only. The additional accuracy gained, however, will scarcely repay for the extra time and labor required, and even in this case, as will be seen by a reference to the above determinations, the error may amount to ·01 parts N per 100,000.

In the course of a great many experiments I have observed, even when the utmost care has been taken, that two solutions, nominally containing the same amount of nitric acid, occasionally give a very slight though distinctly perceptible difference in shade when tested side by side. Whatever may be their cause, such differences are extremely slight, and if proper care be taken do not materially affect the value of the process.

I cannot too strongly insist upon the necessity of scrupulous cleanliness at all stages of the analysis. The quantity of water operated upon is so small, that if the greatest care be not exercised throughout, sources of con-

siderable error may be readily introduced. The test tubes used in the process may be conveniently 5 x ⅝ inches in size. It is scarcely necessary to add that they should always be dry when used, and rinsed out carefully with distilled water when put aside.

In comparing the color given by a water with that produced by standard potassic nitrate, it is necessary only to examine the solutions *through* the tubes; differences in shade, which can only be detected by looking through the length of the columns of liquid, may be disregarded. It is well to use the same 2 cc. pipette for measuring both the water and the standard potassic nitrate; the effect of any error in graduation is thus neutralized.

I have made experiments to ascertain whether the intensity of color produced is strictly proportional to the nitric acid present, with a view to render the use of a colorimeter possible and thus to avoid the time and trouble necessary to match the colors given by the waters. The result of these experiments, which were made with a Duboscq instrument, show conclusively that the changes already referred to in both tint and intensity after the addition of the carbazol, occur more rapidly with the light than with the dark solutions, and hence they are not strictly comparable.

INFLUENCE OF NITRITES.

It has been already pointed out that nitrous acid behaves similarly to nitric acid in its action on a sulphuric acid solution of carbazol. In order to estimate to what extent its influence would be felt when present in the water to be examined for nitrates, several solutions of silver nitrite were carefully prepared and estimated precisely as if they contained a nitrate.

The results obtained are given in the following table:

RESULTS EXPRESSED AS N IN 100,000 PARTS.

Present as $AgNO_3$.	*Found.*	*Error.*	*Corrected by deducting one-fifth from amount found.*
·10	·12	·02	·096
·20	·25	·05	·200
·30	·37	·07	·296

It will be observed that the error may be very nearly corrected by deducting one-fifth from the amount found. In the presence of nitrates, this correction, of course, will only be possible in cases in which the quantity of the nitrous acid present has been previously ascertained. A correction, however, would be rarely necessary.

INFLUENCE OF IRON.

Although a solution of ferrous sulphate gives no reaction with carbazol, nitrates are apt to be overestimated in the presence of iron in the ferrous condition. Ferric salts, however, acting like other oxidizing agents, are themselves able to give the characteristic green color with carbazol. I have made a number of experiments with solutions of potassic nitrate in the presence of both Fe″ and Fe‴ in varying amounts, and have ascertained that if iron be not present in quantities greater than 0·1 parts per 100,000, the error will not exceed ·01 parts in 100,000. The condition of a water with regard to iron may be ascertained sufficiently accurately in a few seconds by the help of ammonic sulphide. As this is a test which should always be made in the examination of water for sanitary purposes, no extra trouble is involved. In a case in which iron is present in large quantities, it can be easily eliminated by rendering the water slightly alkaline, evaporating to dryness, and redissolving the soluble residue in the same volume of pure distilled water, as was taken of the water under examination.

INFLUENCE OF CHLORIDES.

Chlorides form by far the most serious source of error in this process by intensifying the action of the nitric acid. If, however, nitrates be absent, chlorides give no reaction with carbazol. Were it not for the fact that the chlorine can be perfectly removed in the space of a very few minutes, the general usefulness of the method would be much restricted. In order to remove the chlorine I use the standard sulphate of silver already referred to, 1 cc. of which, when consumed by 100 cc. of water, is equivalent to one part of Cl in 100,000 parts of water. Having first determined the chlorine present, by means of a standard nitrate

of silver solution of equivalent strength, the exact quantity of sulphate of silver required is known. I proceed as follows: A flask, graduated on the neck at 100 cc. and 110 cc., is filled up to the 100 cc. mark with the water to be examined. The necessary quantity of sulphate of silver is next added and then 2 cc. of the solution of aluminic sulphate previously described; finally, the contents of the flask are brought up to the 110 cc. mark by the addition of pure distilled water. The whole is shaken up and filtered; the first portion of the filtrate, which will contain any foreign substances derived from the filter paper, is thrown away. The aluminic sulphate, by reacting with the carbonates usually present in the water, and thus giving rise to the precipitation of alumina, facilitates the removal of the precipitated chloride of silver, which otherwise, under the conditions given above, is extremely difficult to separate and may even still pass through the paper after refiltering many times. When the filtrate is perfectly bright, a portion is tested to make sure that all the chlorine is removed; the estimation is then made precisely as already described, the amount found being increased by one-tenth to compensate for the dilution of the 100 cc. of the water taken to 110 cc.

It is obvious that such a flask, as I have described, cannot be used in cases in which the Cl exceeds eight parts per 100,000, unless the sulphate of silver solution be of greater strength than that which I have recommended. Similar methods will, however, readily suggest themselves.

In a preliminary paper* published on this process, I mentioned that probably diphenylamine, and other compounds giving similar color reactions in the presence of concentrated sulphuric acid, might be used instead of carbazol for the *quantitative* estimation of nitrates in water. Shortly after this paper appeared, L. Spiegel† called attention to a process worked up by him, in which diphenylamine was actually used for this purpose. This is briefly described in

* *Ber.*, **21**, 3,302; this JOURNAL, **127**, 61.

† *Ber.*, **21**, 3,568.

the *Zeitschrift für Hygiene*, 1887, **2**, 189, and was quite unknown to me. Although differing in detail from that which I have devised, the principle is the same, diphenylamine taking the place of carbazol. Although Spiegel does not mention any experiments made to ascertain the influence of chlorides, it is probable that this will be found as considerable as I have found it in the case of carbazol.

THE ELECTROLYTIC METHOD APPLIED TO MERCURY.—SEPARATION FROM COPPER.

BY EDGAR F. SMITH AND LEE K. FRANKEL.

[*Read at the Stated Meeting of the Chemical Section, April 16, 1889.*]

The electrolytic precipitation of mercury has been successfully performed by different chemists; thus, J. B. Hannay (*Berichte d. d. chem. Gesellschaft*, **6**, 270) recommends a solution of mercury sulphate for this purpose, but gives no quantitative results. F. W. Clarke (*Am. Journal of Science*, **16**, 200; *Zeitschrift für analyt. Chemie*, **18**, 103) separated mercury from the solution of its chloride, freely acidulated with sulphuric acid, by using a current obtained from six Bunsen chromic acid cells. Classen and Ludwig (*Berichte d. d. chem. Gesellschaft*, **19**, 323) employed a mercury solution, rendered slightly acid with nitric acid, and a current affording ·5 – 1·0 cc. OH gas per minute. The time occupied in the deposition, at ordinary temperatures, was twelve to sixteen hours. Hoskinson (*Am. Chem. Journal*, **8**, 209) obtained good results with the nitrate. Smith and Knerr (*Am. Chem. Journal*, **8**, 209) employed a nitrate solution, in which there was considerable acid in excess, and with a current yielding 4 cc. OH gas per minute deposited ·1 gramme of mercury in forty-five minutes. In all of these methods, which permit of the separation of mercury from many other metals, the mercury is thrown out as a mirror-like deposit, and drops of metal are plainly discernible.

We have observed that this metal can be separated without difficulty from solutions containing a large excess of alkaline cyanide, and with a comparatively weak current. The solution used was the chloride. The conditions, time, strength of current and results are as follows, with mercury alone:

Solution Contained Hg.	Found Hg.	Per cent. Difference.	Quantity of KCN.	Total Dilution.	Time in Hours.	Current in cc. OH Gas per Minute.
Grammes.			*Grammes.*	*cc.*		*cc.*
·1945	·1953	+ ·41	·26	175	16	·2
. . .	·1948	+ ·14	·26	. . .	16	·2
. . .	·1946	+ ·05	1·30	. . .	24	. . .
. . .	·1930	— ·77	1·30	. . .	24	. . .
. . .	·1945	. . .	1·30	. . .	12	·2
. . .	·1945	. . .	1·30	. . .	12	. . .
. . .	·1945	. . .	2·60	. . .	12	·2
. . .	·1944	— ·05	·65	. . .	12	. . .
. . .	·1942	— ·14	·65	. . .	12	·2
. . .	·1956	+ ·56	·65	. . .	12	·2
. . .	·1957	+ ·61	1·30	. . .	12	. . .
. . .	·1948	+ ·14	1·30	. . .	12	·2

The deposits in these determinations were compact, rather gray in color, and showed in few cases the drop-like nature so characteristic of mercury.

For washing purposes it was found best to use water only, because when this was followed with alcohol, we noticed that the latter detached thin films of metal, causing loss in consequence. The heat of the hand is sufficient to dry the deposit, though a warm iron plate may be used. Some of the deposits were allowed to dry slowly over sulphuric acid. In our experience, with about a hundred mercury depositions, we observed but five in which there was a slight oxidation of the metal. This only occurred when a film of water remained in contact for some time with the deposited mercury.

In working with copper solutions, under conditions similar to those mentioned above, we discovered that this metal would not separate until the alkaline cyanide was completely decomposed. We, therefore, undertook a series of experiments with solutions containing both mercury and copper, hoping to effect their electrolytic separation. This seemed advisable, as the attempts in this direction had thus

far not been as successful as might be desired (See Luckow, *Zeitschrift für analyt. Chemie*, **8**, 24, and Classen, *Berichte d. d. chem. Gesellschaft*, **17**, 2,467; also *Zeitschrift für analyt. Chemie*, **24**, 247).

Our mercury solution contained the same quantity of metal as in the first experiments. Seventy per cent. of copper was added in each case. The quantity of cyanide varied from ·65 grammes to 3·9 grammes; total dilution was 200 cc., and the current strength varied from ·1 to ·4 cc. OH gas per minute. Time, six to eighteen hours. Ten experiments were performed, and notwithstanding the mercury was completely deposited, slight quantities of copper were likewise thrown out of solution.

Thirty additional experiments were made; in each the quantity of mercury was ·1945 grammes, while the copper varied from fourteen to seventy per cent. The quantity of alkaline cyanide varied from 3·9 to 8·5 grammes; total dilution remained 200 cc. The current averaged ·4 cc. to ·12 cc. OH gas per minute. Time, eighteen hours. The best results were these:

Hg Taken.	Hg Found.	Difference in Per Cent
Grammes.		*Per Cent.*
·1945	·1932	— ·66
. . . . .	·1920	— 1·28
. . . . .	·1927	— ·92
. . . . .	·1936	— ·46
. . . . .	·1930	— ·77
. . . . .	·1936	— ·46
. . . . .	·1954	+ ·46
. . . . .	·1938	— ·36
. . . . .	·1923	— 1·13
. . . . .	·1921	— 1·23

These, as well as the results obtained in twenty experiments made later, seem to indicate that the presence of the copper exercises considerable influence upon the precipitation of the mercury—retards it. This fact, we think, was confirmed by ten more experiments, in all of which a slight quantity of the mercury was retained in solution, notwithstanding the current was increased to 1·2 cc. OH gas per minute, and the amount of cyanide considerably reduced.

The time of each precipitation was continued through seventeen hours.

Our attention was next directed to ascertaining whether or not a stronger current might be used to throw out the mercury, and at the same time leave the copper in solution. The results with mercury alone were

Hg Present.	Hg Found.	Difference in Per Cent.	KCN in Grammes.	Total Dilution.	Current in cc. OH Gas per Minute.	Time in Hours.
			Grammes.	*cc.*	*cc.*	
	·1827	— ·27	1·5	200	2·8	16
·1833	·1832	— ·05	1·5	200	2·8	16
	·1834	+ ·05	1·5	200	2·8	16

Using the same quantity of mercury and varying amounts of copper the results were as follows:

Hg Present.	Per Cent. of Cu Present.	Hg Found.	Difference in Per Cent.	KCN in Grammes.	Total Dilution.	Current in cc. OH Gas.	Time in Hours.
	Per Cent.		*Per Cent.*	*Grammes.*	*cc.*		*Hours.*
·1833	1	·1821	— ·65	1·5	200	3·9 cc. to 4 cc. OH per minute.	16
. . .	10	·1828	— ·27	. . .	. . .		. . .
. . .	1	·1821	— ·65	. . .	. . .		. . .
. . .	14	·1833	. . .	. . .	. . .		. . .
. . .	10	·1821	— ·65	. . .	. . .		. . .
. . .	5	·1819	— ·76	. . .	. . .		. . .
. . .	3	·1815	— ·98	. . .	. . .		. . .
. . .	5	·1834	+ ·05	. . .	. . .		. . .
. . .	3	·1836	+ ·16	. . .	. . .		. . .

which are recorded in the order obtained, and while the differences in percentage from that required vary from +·05 per cent. to —·98 per cent., and in six cases out of nine show a deficiency in the mercury, yet a careful qualitative examination of each filtrate failed to detect this metal; the error must therefore be ascribed to other causes. It may not be improper to add that these determinations and separations were not always conducted in the same platinum vessels, and, further, those used by us ranged in weight from sixty-one to 135 grammes.

Where the quantity of copper exceeded twenty per cent. of the mercury, the results were unsatisfactory.

It is well known that silver can be separated quantitatively from its cyanide solution, but whether its separation from copper could be effected in the same manner as that by which mercury and copper were separated, was undetermined; to ascertain this, we made forty experiments; ten of which resulted as follows:

Ag Present.	Copper.	Ag Found.	Difference in Per Cent.	KCN in Grammes.	Current in OH Gas.	Time in Hours.	Dilution.	
	Per Cent.		*Per Cent.*	*Grammes*	*cc.*			
	10	·1257	+ 2·78		1		200	
	10	·1299	+ 6·20		1		200	
	10	·1225	+ ·16		1		200	
	10	·1263	+ 3·20	·5	1	5	200	
·1223	10	·1257	+ 2·78	to	1	to	200	
	10	·1244	+ 1·71	1·0	1	20	200	
	10	·1251	+ 2·20		1		200	
	10	·1242	+ 1·35		1		200	

Copper precipitated with silver.

Later, we diminished the quantity of copper with no better result. On increasing the quantity of cyanide, and also the strength of the current, the silver was very notably retarded in its deposition. After carefully repeating the work with no better outcome, we feel justified in saying that the cyanide method cannot be applied in the electrolytic separation of these two metals.

The current employed by us was obtained from storage batteries of the Julien form. Each cell contains nineteen plates, each of which is five and three-quarter inches square. In a long experience, with almost every form of battery, in electrolytic work, we have not had the same even, steady current for a series of hours as with the Julien form, and recommend it to all engaged in similar experiments. See further *Berichte d. d. chem. Gesellschaft*, **21**, 2,892.

UNIVERSITY OF PENNSYLVANIA,
PHILADELPHIA, April 13, 1889.

ON THE PRESENT CONDITION OF THE PHILADELPHIA WATER SUPPLY. SECOND MONTHLY REPORT.

By SAMUEL C. HOOKER, Ph.D.

[*Read at the Stated Meeting of the Chemical Section, May 21, 1889.*]

In presenting my second report, it is with considerable pleasure that I am able to refer to a matter of very general interest and importance in connection with the water supply of this city. The northwestern portion of the city, which for years has had to endure all the inconveniences attendant upon almost continuously muddy water, will, sometime during the present month, be placed upon an equal footing with the other and heretofore more fortunate sections of the city, and will then be supplied from the East Park reservoir, instead of directly from the Schuylkill. The inhabitants of Philadelphia generally, and more particularly those of the district referred to, may be heartily congratulated on this change, which is unquestionably one of the most important improvements recently made in connection with city affairs. It may be of interest at the present time to recall some facts connected with the supply of this district.

Owing to the considerable elevation of this portion of Philadelphia, there has been no available reservoir high enough to supply it, and consequently water was pumped directly into the mains from the Schuylkill River, a process which had to be kept up continuously, regardless of what might be the condition of the river or how much it might be charged with storm water. The consequence of this is very obvious. At all times the water is more muddy, and frequently unquestionably far less wholesome than that which is supplied to other portions of the city, whose reservoir capacity is sufficiently large to allow of a plentiful supply without the necessity of drawing from the river when in its most unfavorable condition. In order to overcome these difficul-

ties land was purchased some years ago at Cambria and Thirtieth Streets, and a proposed Cambria reservoir was long talked about, but the project of construction presented so many difficulties, and promised to require a so much greater outlay of capital, per unit of storage capacity, than had been necessary in the construction of the other reservoirs, that the plan was eventually abandoned in favor of that to be put in operation in a few days.

As the height of the East Park reservoir is not sufficiently great to enable it to feed this district by gravity, arrangements have been made to pump the water into the mains after it has properly settled.

My first report has been somewhat criticised, and a number of suggestions have been made with regard to the plan of the work I have undertaken. The desirability has been urged, not only of increasing the determinations made, but also of the samples examined. It has been suggested that districts should be sought out, in which, owing to the neighborhood of the dead end of a main or to some other cause, the water is continually inferior to the average supply. The importance of these suggestions is self-evident, and it is much to be regretted that the great amount of time and labor required for carrying them out is entirely out of all proportion to that which I am able to devote to the subject. The *first* object of this investigation is to ascertain the true general condition of the water, as a whole, and when this has been done, it will be time enough to consider local causes of deterioration. With regard to the collection of the samples, I have taken no pains to select points at which, for purely local reasons, the water is likely to be exceptionally bad; neither have I endeavored to get as far away from the dead end of a main as possible, so that the water might be at its best. The samples which I am receiving are, I have every reason to believe, thoroughly representative of the water supplied to the districts in which they are drawn, and, taken as a whole, they unquestionably represent fairly the supply of the city.

With regard to increasing the number of the constituents

determined, I do not think that much would be gained at present by so doing, but as the investigation proceeds it may be found desirable to complete the chain of evidence either for or against the water, and no measures will be left untried which promise any reasonable degree of success in eliciting useful information.

It is much to be regretted that during the past month it has been found necessary to continue pumping from the Delaware at the Kensington station. The water drawn at this point, even when mixed with a large proportion from the Schuylkill, remains very decidedly inferior to the general supply of the city. In a very short time this station is to fall into disuse and no effort should be spared to avoid the necessity of having ever again to resort to it for city supply. Proper provision should be made at once to enable the Water Department, even in the case of emergency, to meet the city's requirements without having to draw a single gallon of water from this unquestionably much polluted point of the Delaware. The best thing that could be done in the public interest would be to dismantle this station in such a way that pumping here in the future would be an absolute impossibility.

Having reference to a statement made in my last report, my attention has been called by the Health Department to the fact that analyses of the water supply have been made regularly for its information during a number of years past. These analyses are withheld from the public, however, because it is feared that improper use might be made of them by individuals, and that figures might be sifted and distorted for the purpose of furthering private ends. If there is no better reasons for withholding these analyses than those which I have mentioned, it is to be hoped that, in future, matters will be regarded in a different light by the Department and that the public will be furnished with the information which rightly belongs to it. It would seem to me far more desirable that the public should be periodically told precisely to what extent the water is good or bad, how it is affected by circumstances attending its distribution, and what probable connection there is at different

times between the condition of the water supply and that of the public health. All figures, moreover, should be furnished to enable those who care to study the matter to do so.

During the period covered by this report, April 19th to May 17th, I have examined twenty-six samples of water and, taken as a whole, I am able to report very favorably on its condition. The water was, however, in a few instances extremely muddy.

The nitrates, which, during a part of the period covered by my first report, were somewhat high, have decreased considerably in quantity; the albuminoid ammonia, representing the nitrogenous organic matter in solution, is lower than that during the previous month and does not vary to any considerable extent in any of the samples examined.

I should have mentioned in my last report, that before determining the albuminoid and free ammonia, the water is carefully filtered through a good quality of paper, so as to remove as well as possible all solid particles, the presence of which would otherwise render it impossible to arrive at any correct idea of the true quality of the water, and would further make any comparison between the water supplied to the various sections of the city worse than useless. In certain cases, a filtration of this character is not able to remove some of the very fine mud held in suspension; this tells unfavorably on the analysis and is one reason, I believe, why, during the period covered by my first report, the Germantown water appeared to less advantage than that in other portions of the city.

My analyses so far show, when considered as a whole, that the actual quality (and here I have no reference to muddiness) of the Germantown water is not inferior to that of the general supply; on the contrary, I believe that if the storage capacity of the reservoir through which it passes, were sufficiently increased to allow the mud to subside properly and to avoid the necessity of drawing water at unfavorable times, it would be distinctly superior to much Schuylkill water that is supplied to other portions of the city.

The almost constantly muddy condition of the German-

town water is, however, most truly deplorable, and the attention of the authorities cannot be too earnestly called to it. The Water Department has certainly no more important task before it than the furnishing of this district with clean water

A diagram is appended, as in my last report, and as several comments have been made in regard to the former one, I would take this opportunity of mentioning that *all* the curves are not constructed to represent parts per 100,000, because if this were attempted, either the size of the diagram would have to be enormously increased, or several diagrams would be necessary.

ANALYSES OF THE PHILADELPHIA WATER SUPPLY.

RESULTS EXPRESSED IN PARTS PER 100,000.

Kensington, Beach and Vienna.

Date. 1889.	*Chlorine.*	*Free Ammonia.*	*Albuminoid Ammonia.*	*Nitrogen of Nitrates.*
April 19th,	·40	·0000	·0090	·08
" 26th,	·36	·0045	·0115	·05
May 3d,	·29	·0000	·0110	...
" 10th,	·37	·0030	·0080	...
" 17th,	·26	·0010	·0050	·11
Average,	·33	·0017	·0089	·08

West Philadelphia.

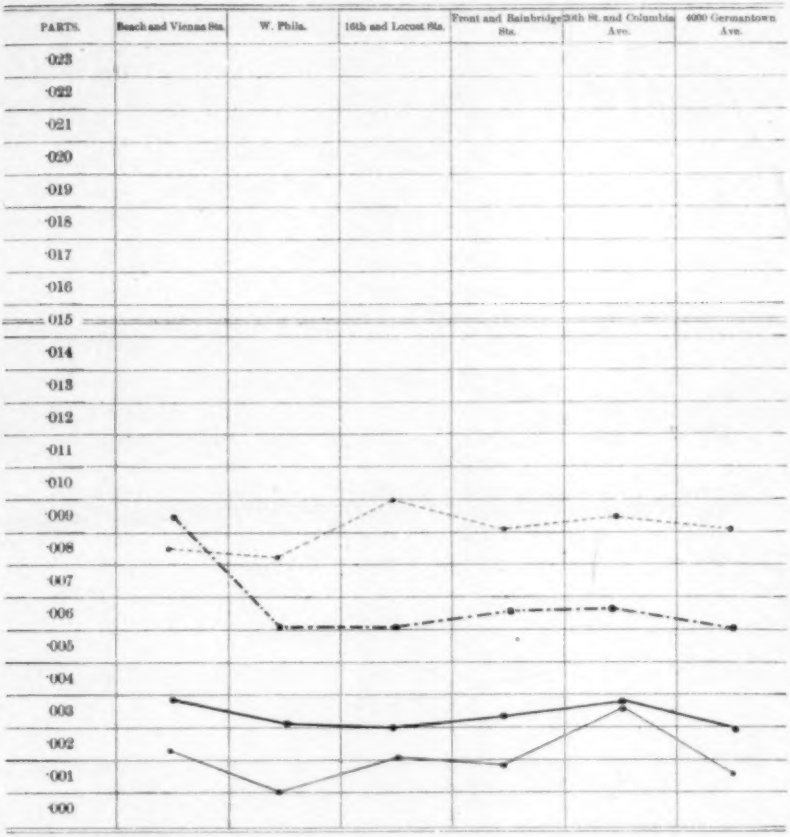
April 19th,	Not analyzed.			
" 26th,	·30	·0015	·0055	·077
May 3d,	·24	·0000	·0060	...
" 10th,	·25	·0005	·0050	...
" 17th,	·26	·0000	·0060	·077
Average,	·26	·0005	0056	·077

Sixteenth and Locust.

April 19th,	Not analyzed.			
" 26th,	·32	·0020	·0060	·088
May 3d,	·19	·0010	·0060	...
" 10th,	·26	·0020	·0050	·099
" 17th,	·26	...	...	·099
Average,	·25	·0016	·0056	·095

DIAGRAM SHOWING THE AVERAGE RELATIVE CONDITION OF THE WATER SUPPLY AT DIFFERENT POINTS OF THE CITY. April 19 to May 17, 1889.

(CONSTRUCTED FROM 26 ANALYSES.)



EXPLANATORY NOTES:

Nitrogen of Nitrates in parts per 10,000.
Representing, when in excess, animal matter, which by natural processes of purification has been rendered harmless.

Albuminoid Ammonia in parts per 100,000.
Representing, when in excess, nitrogenous organic matter of the most dangerous type.

Chlorine in parts per 1,000.
Representing, when in excess, present or past sewage contamination.

Free Ammonia in parts per 100,000.
Representing, when in excess, decaying organic matter.

Provided that the two lower curves do not vary much in height from those given, the condition of the water may be regarded as satisfactory so long as the two upper curves remain below the double line through ·015.

It will be understood that the smaller the quantity of the substances indicated by the above curves, the more satisfactory the condition of the water. In other words, the water is most satisfactory with regard to each particular substance, at the lowest point of each curve.

Front and Bainbridge.

Date. 1889.	Chlorine.	Free Ammonia.	Albuminoid Ammonia.	Nitrogen of Nitrates.
April 19th,	Not analyzed.			
" 26th,	·33	·0005	·0060	·077
May 3d,	·22	·0010	·0075	. . .
" 10th,	·27	·0010	·0055	. . .
" 17th,	·29	·0025	·0060	·088
Average,	.27	·0012	·0062	·082

Twentieth and Columbia Avenue.

April 19th,	Not analyzed.			
" 26th,	·33	·0025	·0070	·066
May 3d,	·26	·0020	·0055	. . .
" 10th,	·31	·0030	·0060	·099
" 17th,	·30	·0020	·0060	·088
Average,	·30	·0027	·0061	·084

4000 Germantown Avenue.

April 19th,	·26	·0025	·0055	·08
" 26th,	·28	·0015	·0065	·088
May 3d,	·21	·0000	·0060	. . .
" 10th,	·24	·0010	·0040	. . .
" 17th,	·25	·0005	·0055	·088
Average,	·24	·0011	·0055	·082

4416 Chestnut Street.

ON THE OCCURRENCE OF PARAFFINE IN CRUDE PETROLEUM.

[*An Abstract of a Thesis by E. A. Partridge, Class of '89, Univ. of Pa. Read before the Chemical Section by Prof. S. P. Sadtler.*]

It is well known that the paraffine obtained by the distillation of petroleum residues is crystalline, while that obtained directly (as in the filtration of residuum) is amorphous. Ozokerite or ceresine differs but slightly from paraffine, the principal distinction being want of crystalline structure in it as found. Other characteristics, such as the melting point, specific gravity, etc., vary in both, and so are not of importance in a comparison. Hence it has been asked, is the paraffine occurring in petroleum and ozokerite identical with that which is produced by their distillation?

As crystalline paraffine could be obtained from ozokerite by distillation alone, many persons have supposed that it was engendered in the process. Recently, however, crystalline paraffine has been obtained from ozokerite by dissolving the latter in warm amyl alcohol; on cooling the greater part separates out in crystals having the lustre of mother-of-pearl. By repetition of this process, a substance is obtained that is scarcely to be distinguished from the paraffine obtained by distillation. Apparently there exists then in ozokerite, together with paraffine, other substances not capable of crystallization which keep the paraffine from crystallizing. These colloids appear to be separated by amyl alcohol in virtue of their greater solubility in that menstruum. It is also reasonable to suppose that they undergo change or decomposition by distillation.

So as petroleum residues are amorphous, and the crystalline paraffine is first produced by distillation, it has been argued that the paraffine present in crude petroleum is approximately the same thing as ozokerite.

This, however, is not sufficient to establish the pyrogenic origin of all crystallized paraffine, as crystals can be obtained from the amorphous residues by distillation at normal or reduced pressure or in a current of steam. To explain these facts two assumptions are possible. Either the chemical and physical properties of all or some of the solid constituents are changed by the distillation, and the paraffine is changed from the amorphous into the crystalline variety, or the change produced by the distillation takes place in the medium (*i. e.*, the mother liquid) in which the paraffine exists. The change effected in ozokerite and in petroleum residues when crystalline paraffine is obtained by distillation, is to be regarded as a purification, and can be effected partially by treatment with amyl alcohol. In the same way, by repeated treatment of petroleum residuum with amyl alcohol, a substance of melting point 59° C. can be obtained, which cannot be distinguished from ordinary paraffine.

The treatment with amyl alcohol has therefore accomplished the same results as was obtained by distillation, and

the action is probably the same, *i. e.*, a partial separation of colloid substance. These facts point to the conclusion that crystallizable paraffine exists ready formed in both petroleum and in ozokerite, but in both cases other colloidal substances prevent its cystallization. By distillation, these colloids appear to be destroyed or changed so as to allow the paraffine to crystallize.

It is a generally known fact that liquids always appear among the products of the distillation of paraffine, no matter in what way the distillation be conducted. This shows that some paraffine is decomposed in the operation.

The name *proto-paraffine* has been given to ozokerite, and to the paraffine of petroleum in contra-distinction to *pyro-paraffine*, the name that has been applied to the paraffine obtained by distillation from any source.

According to Reichenbach, paraffine may crystallize in three forms: needles, angular grains and leaflets having the lustre of mother-of-pearl. Hofstädter, in an article on the identity of paraffine from different sources, confirmed this statement, and added farther that at first needles, then the angular forms, and then the leaflets are formed. Fritsche found, by means of the microscope, in the ethereal solution of ozokerite, very fine and thin crystal-leaflets concentrically grouped, and in the alcoholic solution fine irregular leaflets. Zaloziecki has recently developed these microscopic investigations to a much greater extent. According to this observer, the principal part of paraffine, as seen under the microscope, consists of shining stratified leaflets with a darker edge. The most characteristic and well-developed crystals are formed by dissolving paraffine in a mixture of ethyl and amyl alcohols and chilling. The crystals are rhombic or hexagonal tablets or leaves, and are quite regularly formed. They are unequally developed in different varieties of paraffine. The best developed are those obtained from ceresine. Their relative size and appearance give an indication as to the purity of the paraffine, and, as they are always present, they are to be counted among the characteristic tests for paraffine. Reichenbach observed that mere traces of empyreumatic oil prevented their formation.

The old method of determining the amount of paraffine in petroleum was to carry out the refining process on a small scale; that is, to distil the residue from the kerosene oils to coking, chill out the paraffine, press it thoroughly between filter-paper and weigh the residue. The sources of error in this procedure are manifold; the principal one is the solubility of paraffine in oils, which depends upon the character of both the paraffine and the oil, and also upon the temperature. The next greatest source of error is variation in the process of distillation and the difference between working on the small scale and on the large scale.

In most cases, where a paraffine determination is to be carried out, one has to deal with a mixture of paraffine with liquid oils. Now, paraffine is not a substance defined by characteristic physical properties which distinguish it from the liquid portions of petroleum. It consists of a mixture of homologous hydrocarbons, which form a solid under ordinary conditions. The hydrocarbons of this mixture show a gradation in their properties, and gradually approximate to those which are liquid at ordinary temperatures. It is a well-known fact that a separation of these homologues is entirely impossible by distillation. It has also been ascertained that the liquid constituents of petroleum do not always possess boiling points that are lower than those of the solid constituents. This shows that we have to deal not merely with hydrocarbons of one but of several series.

When determinations of the amount of paraffine are to be made, then it becomes necessary to specify with exactness what is to be called paraffine. The most definite property that can be made use of for this purpose is the melting point. For several reasons it is convenient to include under this name hydrocarbons of melting point as low as 35°–40° C.

The method proposed by Zaloziecki for the determination of paraffine is the following: The most volatile portions of the petroleum are separated by distillation, until the thermometer shows 200° C. These portions are separated, as they exert great solvent action upon paraffine. At the same time he finds that no pyro-paraffine is formed under this temperature. A weighed portion of the residue

is taken and mixed with ten parts by weight of amyl alcohol and ten parts of seventy-five per cent. ethyl alcohol: the mixture is then chilled for twelve hours to 0° C. It is then filtered cold, washed first with a mixture of amyl and ethyl alcohols, and then with ethyl alcohol alone. The paraffine is transferred to a small porcelain evaporating dish and dried at 110° C. It is then heated with concentrated sulphuric acid to 150°–160° C. for fifteen to thirty minutes with constant stirring. The acid is then neutralized and the paraffine extracted by petroleum ether. On evaporation of the solvent, the paraffine is dried at 100° C. and weighed. Zaloziecki found, according to this method, in three samples of Galician petroleums, 4·6, 5·8 and 6·5 per cent., respectively, of proto-paraffine. The method was carried out as above, with four samples of American petroleums, Colorado oil from Florence, Col.; Warren County oil from Wing Well, Warren, Pa.; Washington oil from Washington County, Pa.; Middle District oil from Butler County, Pa., all furnished by Professor Sadtler.

They were very different in physical properties and in appearance, the Colorado oil being a much heavier oil than the others and the Washington oil being an amber oil, while the other two were of the ordinary dark green color and consistence. The losses on distillation to 200° C. were very different, being about one-tenth in the case of the Colorado oil and nearly one-half in the case of the others. The percentages of partially refined proto-paraffine in the four reduced oils (all below 200° C. off) were as follows: for the Colorado oil, 23·9 per cent.; for the Warren oil, 26·5 per cent.; for the Washington oil, 26·6 per cent.; and for the Middle District oil, 28·2 per cent.

The question now arises, what value has this determination of the proto-paraffine which may exist in an oil. As before said, a portion of the paraffine is always decomposed in distillation at temperatures sufficiently high to drive over the paraffine oils, so the yield of pyro-paraffine is always less than the proto-paraffine shown to be present originally. Zaloziecki found this in the case of the several Galician oils he examined. Corresponding to the 4·6, 5·8 and 6·5 per cent.

of proto-paraffine in the several oils, he obtained 2·18, 2·65 and 2·35 per cent., respectively, of pyro-paraffine.

For the present, however, the extraction of proto-paraffine on a large scale by means of such solvents as amyl and ethyl alcohols is out of the question on account of their cost. A distillation, under reduced pressure and with superheated steam, would, however, prevent much of the decomposition of the original proto-paraffine and increase the yield of pyro-paraffine.

This study of Zaloziecki's method and the examination of American oils was suggested by Professor Sadtler and carried out in his laboratory.

GIFTS TO THE LIBRARY OF THE FRANKLIN INSTITUTE.

Agricultural Experiment Station of the Agricultural and Mechanical College, Auburn, Ala. Bulletin No. 5. New Series. From the Station.

Albany Medical College. Historical Address by David Murray. From Willis G. Tucker, M. D.

American Institute of Mining Engineers:

Rothwell. The Present Status of Electric Transmission of Power.

Cook. Tuyere Slagging-Valve.

Hofman. Gold-Milling in the Black Hills.

Glenn. Notes on the Electrolytic Assay of Copper.

Blake. Note upon some Results of the Storage of Water in Arizona.

Blake. The Copper Deposits of Copper Basin, Arizona, and their Origin.

Bowden. Biographical Notice of Eric C. Schaufuss.

Cook. The Wenström Magnetic Separator.

Potter. Note on the Use of Crude Petroleum as Fuel for Raising Steam at the South Chicago Works.

Carpenter. Ore-Deposits of the Black Hills of Dakota.

Proceedings of the Fifty-third (Nineteenth Annual) Meeting, New York City, February, 1889.

Smith. Nails from Tin Scrap.

Hunt. Steel Rails. Discussion.

Potter. Some Thoughts Relating to the American Institute of Mining Engineers and its Mission.

Munroe. An Automatic Dumping Cradle for Mine Cars.

Williams. The Determination of Silicon in Ferro-Silicons; its Occurrence in Aluminium as Graphitoidal Silicon; and a Study of its Reactions with Alkaline Carbonates.

American Institute of Mining Engineers:
Munroe. Automatic Dumping Cradle. Discussion.
Ashburner. The Geology of Buffalo as Related to Natural-Gas Explorations along the Niagara River.
From the Institute.

American Iron and Steel Association. Annual Statistical Report for 1888.
From the Secretary.

Arkansas Geological Survey. Annual Report for 1888. Vol. 1.
From the State Geologist.

Association Française pour l'Avancement des Sciences. Sixteenth and Seventeenth Session. 1887 and 1888. From the Association.

Baltimore Health Department. Annual Report for 1888.
From the Secretary of the Department.

Bibliotheques et des Archives. Annuaire 1889. Bulletin No. 2. 1888.
From the Minister of Public Instruction.

Board of Supervising Inspectors of Steam Vessels. Proceedings. Thirty-Seventh Annual Meeting. Part 1. From the Board.

Bureau of Statistics. Quarterly Report No. 2. 1888–89.
From the Chief of the Bureau.

Camden, N. J. Department Reports. 1888.
Reports of the Water Department for 1873, 1874, 1875, 1876, 1878, 1886, 1887 and 1888.
From the Chief Engineer, Water Department.

Canadian Society of Civil Engineers. Transactions. Vol. 2. Part 2.
From the Society.

Carnegie, Andrew. Industries of Pennsylvania.
From the American Iron and Steel Association.

Carnegie, Andrew. Pennsylvania's Industries and Railroad Policy.
From the Author.

Chicago. Historical Society Proceedings. Quarterly Meeting. April, 1889.
From the Society.

Cincinnati Corrugating Company. Catalogue. From the Company.

Clifford, H. E. H. Note on the Efficiency of Small Electro-Motors.
From the Author.

Connecticut Agricultural Experiment Station. Annual Report for 1889. Part 1. Bulletin No 97. From the Station.

Coutie, Wm. Atoms of Elements. Part 2. From the Author.

Davenport Academy of Natural Sciences. Proceedings. Vol. 5. Part 1.
From the Academy.

Dexter Manufacturing Company. Catalogue of Folding Machines.
From the Company.

Dickinson College. One Hundred and Sixth Annual Catalogue.
From Prof. Chas. F. Himes.

Electrical Periodicals; 363 odd numbers of the following journals:
Electrician. London.
Electrician. New York.
Electrical Engineer. London.

Electrical Periodicals:

Electrical Review. New York.
Electrical World. New York.
Telegraphic Journal. London.
Western Electrician. Chicago. From David Brooks.

Engineers' Society of Western Pennsylvania. Proceedings. March 19, 1889. From the Society.

English Pilot. Part 1 and 4th book. London, 1629 and 1638. From Dr. Isaac Norris.

Fall River, Mass. Eleventh Annual Report of the Board of Health for 1888. From the Board.

Financial and Mining Record. Vols. 19 to 22. 1886 and 1887. From Percy A. Bivins.

Franklin Reformatory Home. Seventeenth Annual Report. From the Home.

Grand Trunk Railway of Canada. Semi-Annual Report, December 31, 1888. From Mr. Hickson.

Hartford, Conn. Fourth Annual Report of the Board of Health for year ending February 28, 1889. From the Board.

Hartford, Conn. Thirty-fifth Annual Report of the Board of Water Commissioners for year ending March 1, 1889. From the Board.

Harvard College Observatory Annals. Vol. 18. Parts 7 and 8. Vol. 20. Part 1. From Prof. E. C. Pickering.

Henry Draper Memorial. Third Annual Report. From the same.

Hydrographic Office United States. Pilot Chart of the North Atlantic Ocean. May, 1889. From the Philadelphia Branch.

Imperial University, Tokyo. Journal of the College of Science. Vol. 2. Part 5. From the University.

Indiana. Geological Reconnaissance.
Geological Report, 1879–80. From John A. Oakes.

Iron and Steel Institute. London. Journal No. 2. 1888. From the Institute.

Manchester Steam Users' Association, Boiler Explosions. Board of Trade Reports. 1879–82. From the Association.

Massachusetts State Agricultural Experiment Station. Sixth Annual Report. Bulletin No. 38. From the Station.

Master Builders' Exchange. Hand-book. From the President.

Mechanical Tests of Building Material made for the Commissioners for the Erection of the Public Buildings, Phila. From Chas. E. Ronaldson.

Mercantile Library of Philadelphia. Bulletin No. 27. From the Library.

Meteorological Observations Recorded at Six Stations in India. October to December, 1888. From the Meteorological Department of India.

Michigan State Board of Health. Sixteenth Annual Report. From the Secretary.

Minnesota Geological and Natural History Survey. Sixteenth Annual Report. From the State Geologist.

National Association of Builders. Third Annual Convention.
From the Secretary.

New Bedford, Mass. Tenth Annual Report of the Board of Health.
From the Board.

New Bedford, Mass. Nineteenth Annual Report of the Water Board for 1888. From the Board.

New Jersey Agricultural Experiment Station. Bulletin No. 52 to 55 inclusive.
From Prof. G. H. Cook.

New Jersey Historical Society. Proceedings. Second Series. Vol. 10. No. 3. From the Society.

New Jersey State Lunatic Asylum. Annual Reports for 1848 to 1888 (1860 to 1870 in duplicate).
From the Hon. Caleb S. Green, Secretary of the Asylum.

New York City Aqueduct Commission. Report on Researches concerning High Masonry Dams. From the Commission.

New Zealand Meteorological Report for 1885.
From the Director of the Colonial Museum.

Norfolk and Western Railroad Company. Eighth Annual Report.
From the Company.

North Carolina Agricultural Experiment Station. Bulletin No. 62½.
From the Station.

Osborne, Richard B. Professional Biography of Moncure Robinson.
From the Author.

Patent Office, British. Abridgments relating to:
Acids, Alkalies, etc. Division 2 and 3.
Wearing Apparel. Division 1.
Name Index to November, 1888.
Subject Matter Index, November, 1888.
Specifications of Inventions. Vols. 42, 44 to 72, 74 and 75.

Patent Office, United States. Specifications and Drawings, March, 1889.
From the Office.

Pennsylvania State College. Catalogue. 1888–89. From the College.

Peters, C. H. F. Celestial Charts made at the Litchfield Observatory of Hamilton College. From the Author.

Philadelphia City Institute. Thirty-seventh Annual Report.
From the Managers.

Plutarch's Lives. Cassell's National Library. From Cassell & Co.

Practische Maschinen Constructeur, Erster und Zweiter Jahrgang. 1868 and 1869. From Hugo Bilgram.

Providence Public Library. Eleventh Annual Report.
From the Librarian.

Reading, Pa. Report of the Board of Health for 1888. From the Board.

Rose Polytechnic Institute. Seventh Annual Catalogue.
From the Institute.

Royal Statistical Society. General Index to Journal. From the Society.

Signal Office, U. S. A. Appendix 5 to the Annual Report of the Chief Signal Officer. 1888. From the Office.

Springer Torsion Balance Company. Prospectus. From the Company.

Taunton, Mass. Annual Report of the Board of Health. 1888. From the Board.

Trade Catalogues. Branford Lock Works.
Churchill & Co.
Disston & Sons.
Ironmonger Diary. 4 vols.
Markley, Alling & Co.
Montgomery & Co.
Russell, Erwin & Co. 3 vols.
Sargent & Co.
Simmons Hardware Co.
Walter's Sons.
From A. C. Albrecht, Superintendent American Machine Co.

Treasury, U. S. Annual Report of the Secretary. 1888. Finance. From the Secretary.

United States Commission of Fish and Fisheries. The Fishery Industry of the United States. Section 5. Vols. 1 and 2. From the Commission.

U. S. Department of Agriculture:
Division of Chemistry. Bulletin No. 20.
Division of Entomology. Periodical. Bulletin No. 9.
Hog Cholera, its History, Nature and Treatment.
Quarterly Bulletin. March, 1889.
Report of the Statistician, No. 61. From the Department.

U. S. Department of State. Report from the Consuls, February, 1889. From the Department.

United States Geological Survey. Seventh Annual Report, 1885–86. From the Director.

United States Mint. Annual Report of the Director for 1888. From the Director.

University Club of Philadelphia. Officers, Committees, Charter, By-Laws, etc. From Henry Pemberton, Jr.

University of Wisconsin. Agricultural Experiment Station. Bulletin No 19. From the Station.

Vereines Deutscher Ingenieure. Statut, 1867. Zeitschrift, Band 12 to 17. 1868 to 1873. From Hugo Bilgrim.

Waltham, Mass. City Documents for 1866, 1867, 1868, 1869, 1870, 1871, 1880, 1881, 1883, 1885, 1886, 1887.
The Taxable Valuation of the Real and Personal Estates, with the Amounts of Tax in Waltham, for the year 1885. From the City Clerk.

Wisconsin. Second and Third Biennial Reports of the State Board of Charities and Reform for 1885–86 and 1887–88. From the Board.

Wisconsin. State Historical Society. Proceedings Thirty-sixth Annual Meeting. From the Society.

ANNUAL REPORT

OF THE DIRECTOR OF THE DRAWING SCHOOL OF THE FRANKLIN INSTITUTE, FOR THE SESSIONS 1888–1889.

The number of pupils attending the Drawing School has been less this year than last, but as other similar schools have had the same experience, it is evidently due to outside causes and does not indicate any loss of prestige. On the contrary, the system of instruction has been greatly improved, and the efficiency correspondingly increased. This is particularly the case with the Junior and Intermediate Classes in Mechanical Drawing, where all problems not directly useful have been eliminated, and the course so modelled as to be logical, concentrated, concise, and at the same time more comprehensive than ever before. Excellent opportunity is given the pupils to become thoroughly grounded in the principles, and any failure on the part of any of them to profit by it, is due either to natural incapacity or to want of appreciation of or lack of attention to, the theoretical studies which constitute a large portion of the work. If those desirous of learning Mechanical Drawing would only commence at the beginning and go understandingly through the entire course, they would become thoroughly interested in the subject and would, at the end, be in a position to make themselves immediately useful in a draughting office or industrial establishment, and would have mastered things which, as apprentices in such establishments, they would never get an opportunity to learn.

This is equally true of those desiring to take up Architectural Drawing. It is the ability to handle crooked, complicated and difficult problems that makes any individual architect, draughtsman or mechanic more valuable than his fellows, and although a natural gift of genius may occasionally supply the place of education and training to some extent, yet such gifts are rare, and even when they do occur, the education has to be obtained afterwards by overwork.

The Free Hand Classes have been favored this year with an unusual amount of natural talent and have consequently been very successful. Considering the total number of hours actually spent at the work, the quantity and quality of the result attained make a gratifying showing.

Much credit is due to the ability and earnestness of the instructors: Messrs. Clement Remington, Willis H. Groat, John F. Rowland and George W. Irons.

The following pupils are entitled to Honorable mention:

In the Senior Mechanical Class.

William H. Schalliol,	Howard W. White,	Thomas W. Lawrence,
A. S. Berquist,	Lucien E. Picolet,	John Morris Bush.

In the Intermediate Classes.

John S. Rooke,	Charles W. Godfrey,	Gustav Friedler,
George C. Tilton,	Clifford M. Talley,	Robert G. Hienerwald,
Alexander H. Watt,	Donald Frazer,	W. E. Wilkinson.

In the Junior Mechanical Classes.

Frank S. Thompson,	John G. Johnson,	J. Hüster,
John Simpson,	Henry J. Upp,	James L. Garnett,
	W. A. Leavitt, Jr.	

In the Architectural Class.

George W. Haldeman,	Paul A. Davis,
Charles B. Jarden,	Henry Kerr.

In the Free Hand Class.

Robert F. Schleicher,	Charles Nacke,	Arthur B. Davenport,
Oscar Wenderoth,		Kate F. Dinan.

In the Oil-Painting Class.

Charles A. Koch,	Mrs. L. Nace,	George Lethy.

The following pupils are awarded scholarships from the B. H. Bartol Fund, entitling them to tickets for the next term, beginning September 23, 1889:

Intermediate Mechanical Class.

John S. Rooke, Donald Frazer.

Junior Mechanical Class.

Frank S. Thompson, J. Hüster.

Architectural Class.

Paul A. Davis.

Free Hand Class.

Robert F. Schleicher.

The following pupils having attended a full course of four terms, with satisfactory results, are awarded certificates to that effect:

Louis Eichhorn,	James Exley,	George E. Drum,
William H. Schalliol,	Charles W. Leng,	William Grieser,
Howard W. White,	George Bardsley,	George W. Haldeman,
Lucien E. Picolet,	Henry H. Alcock,	Daniel McLaughlin,
Thomas W. Lawrence,	Emil Lukert,	William Bartholomew,
Morris T. Patterson,	George Fred. Becker,	William L. Bushnell,
William Halpin,	Charles Doellber,	Howard M. Craig,
John Morris Bush,	Kenneth J. Easby,	John Kenney,
William C. Gray,	George S. Neff,	George H. Robinson,
William C. Brockmeyer,	Leburton P. Gardner,	Frederick De Ginther,
William H. Lippert,		Howard L. Dunlop.

It is to be regretted that the class-rooms are not sufficient to accommodate the entire school on two evenings in the week, as was the original practice. Such an arrangement would increase the energy and enthusiasm and remove the tiresome effect of continuous night work from the instructors. The school sessions could then be fixed on different evenings from the lectures, and thus avoid the annoyance to the lecturer and audience, caused by the noise on the stairway, made by a few ill-bred and unruly pupils during the exit of the classes. I shall endeavor to plan a rearrangement of the rooms to accomplish this.

WILLIAM H. THORNE,
Director.

Franklin Institute.

[*Proceedings of the Stated Meeting, held Wednesday, May 15, 1889.*]

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, May 15, 1889.

JOSEPH M. WILSON, President, in the Chair.

Present, 128 members and sixteen visitors.

Additions to membership since last report, 39.

Mr. S. LLOYD WIEGAND was elected as a trustee of the Elliot Cresson Fund, to fill the vacancy caused by the death of JOHN WIEGAND.

Mr. JAMES S. MCCOY, of New York, gave a description of the Pneumatic Tool of the American Pneumatic Tool Company and exhibited the tool in operation surfacing and engraving stone, engraving upon wood, executing *repoussé* work, etc. Specimens of the products were exhibited.

The subject was referred for investigation to the Committee on Science and the Arts.

Mr. FRED. E. IVES made some remarks on the subject of portable optical lanterns, and exhibited vertical lantern, megascope, microscope, polariscope and spectrum projection attachments of novel construction, adapted to his portable folding lantern.

Mr. IVES' improvements were referred to the same committee for investigation and report.

Mr. S. LLOYD WIEGAND presented an abstract of the report of the Committee on Science and the Arts on "James Atkinson's Gas Engine," illustrating the subject by the use of a number of lantern slides.

The Secretary's report embraced some comments on the Paris Exhibition and the exhibition of a number of views of some of the most notable of the various buildings and structures.

Adjourned.

WM. H. WAHL, *Secretary.*

PENNSYLVANIA STATE WEATHER SERVICE.

MONTHLY WEATHER REVIEW

FOR NOVEMBER, 1888.

Prepared under the Direction of the Committee on Meteorology of the FRANKLIN INSTITUTE.

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, November 30, 1888.

TEMPERATURE.

The mean temperature for November was 42°·0, which is about normal. The average daily range was 16°·9. The mean of the daily maxima was 50°·6, and that of the daily minima 33°·7.

The following stations reported the highest average temperature for the month: Shamokin, 47°·9; Catawissa, 46°·3; Pottstown, 46°·0, and Philadelphia, 45°·8.

The lowest averages were, Greenville, 35°·3; Eagles Mere, 37°·0; Wellsboro, 37°·2; Phillipsburg, 37°·5, and Dyberry, 37°·6.

The highest temperatures recorded during the month were, Meadville, 79°; Phillipsburg, 77°; Catawissa, 77°; Carlisle, 77°, and Indiana, 77°. These occurred on the 1st. The lowest were, Eagles Mere, 4°·0; Wellsboro, 6°·0; Dyberry, 8°·0; Honesdale, 9°·0; Wysox, 10°·0; Phillipsburg, 10°·0; Smethport, 10°·0, and Coudersport, 10°·0. These were noted on the 23d.

BAROMETER.

The barometer averaged about ·08 below the mean for November, with the usual extremes. Most of the high pressures occurred on the 17th, 18th and 23d. The coldest period of the month was during the high pressure of the 23d. The low pressures were during the 10th and 26th, and were attended

by heavy rains. The low of the 26th caused severe gales along the coast, where considerable damage was done to shipping and sea-side resorts.

PRECIPITATION.

An average rainfall of 3·37 inches was quite evenly distributed throughout the state. The greatest amount in any one day fell on the 15th, on which date several stations had over one inch. There were ten days during the month on which general rains did not occur. Several light snowfalls were reported. The largest total snowfalls for the month, in inches, were, Eagles Mere, 10·50; Wellsboro, 6·55; Rimersburg, 4·25; Grampian Hills, 4·00; Carlisle, 3·00; Uniontown, 3·25; Huntingdon, 3·35; Scranton, 3·00; New Bloomfield, 3·00; Girardville, 3·00, and Dyberry, 3·00. Very little remained on the ground at the end of the month.

WIND AND WEATHER.

The average direction of wind was from the west. A severe northerly gale took place on the 26th. The month as compared with other Novembers had no distinguishing characteristics.

Average number.—Rainy days, 11; clear days, 9; fair days, 7; cloudy days, 14.

MISCELLANEOUS PHENOMENA.

Thunder-Storms.—Quakertown, 10th; New Bloomfield, 10th; Wellsboro, 10th; Columbus, 10th; Dyberry, 10th.

Snow.—Charlesville, 11th, 18th, 19th, 27th, 29th; Reading, 23d, 24th, 25th; Hollidaysburg, 18th, 26th; Wysox, 25th; Emporium, 11th, 16th, 17th, 18th, 26th, 29th; State College, 10th, 11th, 19th, 26th, 28th, 29th; Phillipsburg, 11th, 16th, 17th, 18th, 26th, 28th, 29th, 30th; West Chester, 24th, 25th; Coatesville, 24th, 25th, 26th; Rimersburg, 11th, 16th, 17th, 26th, 28th, 29th, 30th; Grampian Hills, 18th, 26th, 28th, 30th; Lock Haven, 18th, 26th; Catawissa, 17th, 18th, 25th; Meadville, 28th, 29th; Carlisle, 18th, 25th; Uniontown, 16th, 26th; McConnellsburg, 19th; Huntingdon, 19th, 26th; Indiana, 26th, 29th; Scranton, 25th; Lancaster, 23d, 25th, 26th; New Castle, 16th, 26th, 27th; Greenville, 16th, 17th, 18th, 26th, 27th, 28th, 29th, 30th; Bethlehem, 23d, 25th; New Bloomfield, 18th; Philadelphia, 24th, 25th, 26th; Coudersport, 26th, 30th; Eagles Mere, 11th, 16th, 17th, 18th, 25th, 29th, 30th; Wellsboro, 11th, 16th, 19th, 26th; Columbus, 16th, 27th, 28th, 29th, 30th; Dyberry, 19th, 25th; York, 25th.

Coronæ.—Catawissa, 14th; Huntingdon, 17th; Lebanon, 17th, 20th, 21st; Eagles Mere, 12th, 15th, 17th; Dyberry, 14th; York, 17th.

Solar Halos.—Charlesville, 2d, 4th, 14th; Altoona, 8th; Lebanon, 14th; Greenville, 4th, 14th; Philadelphia, 14th; Eagles Mere, 14th; Wellsboro, 14th; Dyberry, 14th.

Lunar Halos.—Charlesville, 17th; Reading, 14th, 19th; Hollidaysburg, 14th, 17th; Quakertown, 14th; West Chester, 17th; Rimersburg, 14th; Grampian Hills, 13th, 17th; Carlisle, 17th, 22d; Indiana, 14th; Lancaster, 15th; New Castle, 17th; Lebanon, 14th, 17th; Greenville, 14th, 17th; Phila-

Monthly Summary of Reports by Voluntary Observers of the Pennsylvania State Weathe

County.	Station.	Elevation above Sea Level (feet).	Barometer.			Temperature.													Relative Humidity.	Dew Point.	Total Inches.
							Maximum.		Minimum.				Daily Range.								
			Mean.	Highest.	Lowest.	Mean.	Highest.	Date.	Lowest.	Date.	Mean of Maximum.	Mean of Minimum.	Mean.	Greatest.	Date.	Least.	Date.				
Allegheny,[1]	Pittsburgh,	847	30·137	30·540	29·640	44·3	74·3	9	24·0	23	59·3	38·3	14·0	27·1	13	5·5	29	73·6	35·8	3·57
Beaver,	Beaver,	821	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Bedford,	Charlesville,	1,300	. . .	. . .	. . .	40·7	76·0	6	15·0	21	50·7	31·5	19·2	44·0	1	4·0	28	75·7	32·9	3·01
Berks,	Reading,	304	30·152	30·689	29·683	43·7	74·5	6	13·5	22, 23	52·4	34·2	18·2	32·5	1	6·5	27	90·5	40·9	4·06
Berks,	Kutztown—																			
	Keystone State Normal School,	540	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Blair,[2]	Altoona,	1,181	. . .	. . .	. . .	45·4	73·0	7	20·0	21	54·8	36·0	18·8	29·6	7	7·0	28	69·6	36·2	2·45
Blair,	Hollidaysburg,	947	. . .	. . .	. . .	41·6	77·0	1	14·0	22, 23	52·0	30·0	22·0	44·0	1	7·0	29	90·0	39·0	3·05
Bradford,	Wysox,	718	. . .	. . .	. . .	39·7	60·2	9	20·0	23	48·4	33·2	15·2	32·5	1	4·5	8	82·6	34·5	3·27
Bucks,	Quakertown,	536	30·140	30·660	29·360	42·3	72·7	6	11·0	23	51·1	34·2	16·9	36·0	1	5·0	15	84·4	37·7	3·71
Butler,	Butler,	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Cambria,	Johnstown,	1,184	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Cameron,	Emporium,	1,030	. . .	. . .	. . .	40·2	73·0	2	12·0	23	50·1	30·0	20·1	42·0	2	5·0	3	77·0	33·0	2·56
Centre,	State College—																			
	Agricultural Experiment Station,	1,191	30·183	29·718	29·630	41·2	72·0	2, 6	12·0	22, 23	48·1	30·0	18·1	30·0	1	7·0	8	77·0	36·5	2·71
Centre,	Phillipsburg,	1,350	. . .	. . .	. . .	37·5	74·0	1	10·0	23	49·8	29·1	20·7	40·0	1	5·0	28	. . .	. . .	3·57
Chester,	West Chester,	455	30·137	30·740	29·313	44·2	72·0	6	16·0	23	51·0	36·9	14·1	25·5	1	7·5	28	72·0	35·5	3·94
Chester,	Coatesville,	380	. . .	. . .	. . .	43·1	76·5	1	16·5	22	53·0	34·4	18·6	38·5	1	8·0	29	. . .	. . .	3·36
Clarion,	Rimersburg,	1,500	. . .	. . .	. . .	40·0	68·0	1, 6, 9	15·0	22	46·0	33·0	13·0	26·0	4	2·0	28	. . .	. . .	. . .
Clarion,	Clarion—																			
	State Normal School,	1,530	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Clearfield,	Grampian Hills,	1,450	. . .	. . .	. . .	37·8	70·0	1, 5, 6	14·0	22, 23	46·2	37·0	9·2	34·0	24	2·0	8	. . .	. . .	3·66
Clinton,	Lock Haven,	560	. . .	. . .	. . .	40·9	69·0	1, 5, 6	14·0	23	49·1	30·5	18·6	38·0	1	6·0	27	. . .	. . .	4·59
Columbia,	Catawissa,	491	. . .	. . .	. . .	46·3	77·0	1	19·0	23	54·0	37·0	17·0	43·0	1	4·0	1	71·0	36·8	3·79
Crawford,	Meadville—																			
	Allegheny College,	1,050	. . .	. . .	. . .	44·2	79·0	1	22·0	21	55·3	37·5	17·8	32·0	4	5·0	30	. . .	. . .	3·22
Cumberland,	Carlisle,	480	. . .	. . .	. . .	44·3	77·0	10	19·0	22	52·9	36·6	16·3	35·5	1	3·5	30	73·2	35·5	2·88
Dauphin,[1]	Harrisburg,	361	30·162	30·750	29·540	42·9	74·0	6	19·0	23	50·4	36·8	13·6	28·0	1	4·8	. . .	76·7	35·5	2·30
Delaware,	Swarthmore—																			
	Swarthmore College,	190	30·120	30·642	29·322	48·0	73·5	6	18·0	23	53·1	33·7	19·4	27·3	4	7·0	28	76·2	38·6	4·13
Erie,	Erie,	681	30·125	30·590	29·600	41·9	74·5	1	20·5	23	50·1	37·1	13·0	24·3	4	4·0	30	. . .	. . .	3·38
Fayette,	Uniontown,	1,000	30·083	30·358	29·635	44·7	76·0	9	22·0	24	52 8	35·7	17·1	33·0	1	6·0	25	78·0	39·0	3·36
Forest,	Tionesta,	1,058	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Franklin,[1]	Chambersburg—																			
	Wilson Female College,	618	30·248	30·641	29·729	37·5	70·0	5, 8	16·0	23	51·9	31·5	20·4	36·0	5	7·5	15	82·2	35·4	. . .
Fulton,	McConnellsburg,	875	. . .	. . .	. . .	42·6	74·0	1	18·0	22, 23	53·1	34·4	18·7	40·0	1	5·0	28	84·0	38·0	3·14
Huntingdon,	Huntingdon—																			
	The Normal College,	650	. . .	. . .	. . .	41·8	77·0	1	12·5	23	50·3	32·6	17·7	45·0	1	5·0	26	. . .	. . .	2·95
Indiana,	Indiana—																			
	State Normal School,	1,350	. . .	. . .	. . .	43·3	73·0	1	16·0	22	50·9	33·3	17·6	38·0	4	2·0	28	85·0	39·2	2·75
Lackawanna,	Scranton,	750	. . .	. . .	. . .	42·0	70·0	2, 9, 10	13·0	22	50·8	31·7	19·1	31·0	2	6·0	29	82·1	37·4	4·56
Lancaster,	Lancaster—																			
	Franklin and Marshall College,	413	30·149	30·723	29·437	44·1	75·0	6	17·0	22, 23	51·1	35·0	16·1	30·5	13	7·5	8	79·7	38·4	2·07
Lawrence,	New Castle,	932	. . .	. . .	. . .	43·2	75·0	1	17·0	28	50·5	31·8	18·7	38·0	1	4·0	28	90·1	40·5	3·99
Lebanon,	Lebanon,	480	30·172	30·751	29·461	43·2	74·3	6	16·8	22	51·7	34·7	17·0	36·2	1	5·7	28	84·9	38·6	3·06
Luzerne,	Drifton—																			
	Drifton Hospital,	1,655	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
McKean,	Smethport,	1,500	. . .	. . .	. . .	39·3	74·0	1	10·0	23	48·2	30·0	18·2	. . .	. . .	. . .	. . .	. . .	. . .	4·01
Mercer,	Greenville—																			
	Thiel College,	1,000	30·061	30·570	29·310	35·3	73·6	1	16·0	21	44·8	30·6	12·2	33·6	4	3·6	30	82·8	30·2	5·17
Montgomery,	Pottstown,	130	. . .	. . .	. . .	46·0	73·0	2	18·0	23	53·0	39·3	13·7	32·0	1	2·0	3	77·5	57·8	3·42
Northampton,	Bethlehem,	360	30·109	30·707	29·407	45·0	73·0	6	14·0	23	52·0	36·0	16·0	35·0	2	5·0	29	78·0	38·0	3·82
Northumberland,	Shamokin,	733	. . .	. . .	. . .	47·9	75·0	1, 2	25·0	26	57·6	37·4	20·2	. . .	. . .	. . .	. . .	. . .	. . .	1·99
Perry,	New Bloomfield,	400	. . .	. . .	. . .	42·3	64·0	6	14·0	23	51·6	32·4	19·2	41·0	4	5·0	29	. . .	. . .	2·89
Philadelphia,[1]	Philadelphia,	117	30·153	30·760	29·330	45·8	75·0	6	18·0	23	54·3	40·4	13 9	25·0	1	5·9	25	76·4	38·3	3·77
Potter,	Coudersport,	1,630	. . .	. . .	. . .	30·3	73·0	2, 3	10·0	23	48·7	30·0	18·7	43·2	2	7·0	11	75·4	34·2	2·10
Schuylkill,	Girardville,	1,000	30·182	30·647	29·641	42·1	70·0	6	11·0	23	49·0	35·0	14·0	30·0	1	7·0	8	. . .	. . .	4·90
Snyder,	Selins Grove,	445	. . .	. . .	. . .	44·7	73·0	6	16·0	23	51·8	37·6	14·2	27·0	1	2·0	30	77·5	37·4	2·40
Somerset,	Somerset,	2,250	. . .	. . .	. . .	39·0	72·0	1	15·0	26	48·4	31·0	17·4	36·0	1	6·0	27	89·1	36·3	2·74
Sullivan,	Eagles Mere,	2,060	30·189	30·707	29·699	37·0	65·0	10	4·0	23	42·3	29·7	12·6	26·0	10	4·0	30	83·0	33·5	6·22
Susquehanna,	Montrose,	1,656	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Tioga,	Wellsboro,	1,327	. . .	. . .	. . .	37·2	76·0	2	6·0	23	50·1	30·5	19·6	9·3	. . .	2·4	. . .	83·6	40·0	3·68
Venango,	Franklin,	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Warren,	Columbus,	1,410	. . .	. . .	. . .	40·6	74·0	1	12·0	23	47·7	33·4	14·3	40·0	14	1·0	10	. . .	. . .	3·81
Wayne,	Dyberry,	1,100	. . .	. . .	. . .	37·6	72·0	2	8·0	23	47·8	26·6	21·2	37·0	1	3·0	30	. . .	. . .	4·61
Wayne,	Honesdale,	1,000	. . .	. . .	. . .	38·0	67·5	10	9·0	23	45·6	30·3	15·3	34·0	2	4·0	16	. . .	. . .	3·97
Westmoreland,	Greensburg,	1,075	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
York,[1]	York,	385	30·136	30·778	29·560	44·0	76·0	6	20·0	22, 23	53·1	35·0	17·2	40·0	1	8·0	28	76·4	36·9	2·68

[1] Observations taken at 8 A. M. and 8 P. M. [2] Observations taken at 12 Noon.

by heavy rains. The low of the 26th caused severe gales along the coast, where considerable damage was done to shipping and sea-side resorts.

PRECIPITATION.

An average rainfall of 3·37 inches was quite evenly distributed throughout the state. The greatest amount in any one day fell on the 15th, on which date several stations had over one inch. There were ten days during the month on which general rains did not occur. Several light snowfalls were reported. The largest total snowfalls for the month, in inches, were, Eagles Mere, 10·50; Wellsboro, 6·55; Rimersburg, 4·25; Grampian Hills, 4·00; Carlisle, 3·00; Uniontown, 3·25; Huntingdon, 3·35; Scranton, 3·00; New Bloomfield, 3·00; Girardville, 3·00, and Dyberry, 3·00. Very little remained on the ground at the end of the month.

WIND AND WEATHER.

The average direction of wind was from the west. A severe northerly gale took place on the 26th. The month as compared with other Novembers had no distinguishing characteristics.

Average number.—Rainy days, 11; clear days, 9; fair days, 7; cloudy days, 14.

MISCELLANEOUS PHENOMENA.

Thunder-Storms.—Quakertown, 10th; New Bloomfield, 10th; Wellsboro, 10th; Columbus, 10th; Dyberry, 10th.

Snow.—Charlesville, 11th, 18th, 19th, 27th, 29th; Reading, 23d, 24th, 25th; Hollidaysburg, 18th, 26th; Wysox, 25th; Emporium, 11th, 16th, 17th, 18th, 26th, 29th; State College, 10th, 11th, 19th, 26th, 28th, 29th; Phillipsburg, 11th, 16th, 17th, 18th, 26th, 28th, 29th, 30th; West Chester, 24th, 25th; Coatesville, 24th, 25th, 26th; Rimersburg, 11th, 16th, 17th, 26th, 28th, 29th, 30th; Grampian Hills, 18th, 26th, 28th, 30th; Lock Haven, 18th, 26th; Catawissa, 17th, 18th, 25th; Meadville, 28th, 29th; Carlisle, 18th, 25th; Uniontown, 16th, 26th; McConnellsburg, 19th; Huntingdon, 19th, 26th; Indiana, 26th, 29th; Scranton, 25th; Lancaster, 23d, 25th, 26th; New Castle, 16th, 26th, 27th; Greenville, 16th, 17th, 18th, 26th, 27th, 28th, 29th, 30th; Bethlehem, 23d, 25th; New Bloomfield, 18th; Philadelphia, 24th, 25th, 26th; Coudersport, 26th, 30th; Eagles Mere, 11th, 16th, 17th, 18th, 25th, 29th, 30th; Wellsboro, 11th, 16th, 19th, 26th; Columbus, 16th, 27th, 28th, 29th, 30th; Dyberry, 19th, 25th; York, 25th.

Coronæ.—Catawissa, 14th; Huntingdon, 17th; Lebanon, 17th, 20th, 21st; Eagles Mere, 12th, 15th, 17th; Dyberry, 14th; York, 17th.

Solar Halos.—Charlesville, 2d, 4th, 14th; Altoona, 8th; Lebanon, 14th; Greenville, 4th, 14th; Philadelphia, 14th; Eagles Mere, 14th; Wellsboro, 14th; Dyberry, 14th.

Lunar Halos.—Charlesville, 17th; Reading, 14th, 19th; Hollidaysburg, 14th, 17th; Quakertown, 14th; West Chester, 17th; Rimersburg, 14th; Grampian Hills, 13th, 17th; Carlisle, 17th, 22d; Indiana, 14th; Lancaster, 15th; New Castle, 17th; Lebanon, 14th, 17th; Greenville, 14th, 17th; Phila-

Monthly Summary of Reports by Voluntary Observers of the Pennsylvania State Weathe

County.	Station.	Elevation above Sea Level (feet).	Barometer.			Temperature.													Relative Humidity.	Dew Point.	Total Inches.
							Maximum.		Minimum.				Daily Range.								
			Mean.	Highest.	Lowest.	Mean.	Highest.	Date.	Lowest.	Date.	Mean of Maximum.	Mean of Minimum.	Mean.	Greatest.	Date.	Least.	Date.				
Allegheny,[1]	Pittsburgh,	847	30·137	30·540	29·640	44·3	74·3	9	24·0	23	52·3	38·3	14·0	27·1	13	5·5	29	73·6	35·8	3·57
Beaver,	Beaver,	821	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Bedford,	Charlesville,	1,300	. . .	. . .	. . .	40·7	76·0	6	15·0	21	50·7	31·5	19·2	44·0	1	4·0	28	75·7	32·9	3·01
Berks,	Reading,	304	30·152	30·689	29·683	43·7	74·5	6	13·5	22, 23	52·4	34·2	18·2	32·5	1	6·5	27	90·5	40·9	4·06
Berks,	Kutztown— Keystone State Normal School,	540	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Blair,[2]	Altoona,	1,181	. . .	. . .	. . .	45·4	73·0	7	20·0	21	54·8	36·0	18·8	29·0	7	7·0	28	69·6	36·2	2·45
Blair,	Hollidaysburg,	947	. . .	. . .	. . .	41·6	77·0	1	14·0	22, 23	52·0	30·0	22·0	44·0	1	7·0	29	90·0	39·0	3·05
Bradford,	Wysox,	718	. . .	. . .	. . .	39·7	62·2	9	10·0	23	48·4	33·2	15·2	32·5	1	4·5	8	82·6	34·5	3·27
Bucks,	Quakertown,	536	30·140	30·660	29·360	42·3	72·7	6	11·0	23	51·1	34·2	16·9	36·0	1	3·0	15	84·4	37·7	3·71
Butler,	Butler,	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Cambria,	Johnstown,	1,184	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Cameron,	Emporium,	1,030	. . .	. . .	. . .	40·2	73·0	2	12·0	23	50·1	30·0	20·1	42·0	2	5·0	3	77·0	33·0	2·56
Centre,	State College— Agricultural Experiment Station,	1,191	30·183	29·718	29·630	41·2	72·0	2, 6	12·0	22, 23	48·1	30·0	18·1	30·0	1	7·0	8	77·0	36·5	2·71
Centre,	Phillipsburg,	1,350	. . .	. . .	. . .	37·5	74·0	1	10·0	23	49·8	29·1	20·7	40·0	1	5·0	28	. . .	. . .	3·57
Chester,	West Chester,	455	30·137	30·740	29·313	44·2	72·0	6	16·0	23	52·0	36·9	14·1	25·5	1	7·5	28	72·0	35·5	3·94
Chester,	Coatesville,	380	. . .	. . .	. . .	43·1	76·5	1	16·5	22	53·0	34·4	18·6	38·5	1	8·0	29	. . .	. . .	3·36
Clarion,	Rimersburg,	1,300	. . .	. . .	. . .	40·0	68·0	1, 6, 9	15·0	22	46·0	33·0	13·0	26·0	4	2·0	28	. . .	. . .	. . .
Clarion,	Clarion— State Normal School,	1,530	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Clearfield,	Grampian Hills,	1,450	. . .	. . .	. . .	37·8	70·0	1, 5, 6	14·0	22, 23	46·2	37·0	9·2	34·0	14	2·0	8	. . .	. . .	3·66
Clinton,	Lock Haven,	560	. . .	. . .	. . .	40·9	69·0	1, 5, 6	14·0	23	49·1	30·5	18·6	38·0	1	6·0	27	. . .	. . .	4·59
Columbia,	Catawissa,	491	. . .	. . .	. . .	46·3	77·0	1	19·0	23	54·0	37·0	17·0	43·0	1	4·0	3	71·0	36·8	3·79
Crawford,	Meadville— Allegheny College,	1,050	. . .	. . .	. . .	44·2	79·0	1	22·0	21	55·3	37·5	17·8	32·0	4	5·0	30	. . .	. . .	3·22
Cumberland,	Carlisle,	480	. . .	. . .	. . .	44·3	77·0	10	19·0	22	52·9	36·6	16·3	35·5	1	3·5	30	73·2	35·5	2·88
Dauphin,[1]	Harrisburg,	361	30·162	30·750	29·540	42·9	74·0	6	19·0	23	50·4	36·8	13·6	28·0	1	4·8	. . .	76·7	35·5	2·30
Delaware,	Swarthmore— Swarthmore College,	190	30·180	30·642	29·322	48·0	73·5	6	18·0	23	53·1	33·7	19·4	27·3	4	7·0	28	76·2	38·6	4·13
Erie,[1]	Erie,	681	30·125	30·590	29·600	41·9	74·5	1	20·5	23	50·1	37·1	13·0	24·3	4	4·0	30	. . .	. . .	3·38
Fayette,	Uniontown,	1,000	30·083	30·368	29·635	44·7	76·0	9	22·0	24	52·8	35·7	17·1	33·0	1	6·0	25	78·0	39·0	3·36
Forest,	Tionesta,	1,058	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Franklin,[1]	Chambersburg— Wilson Female College,	618	30·248	30·641	29·729	37·5	70·0	5, 8	16·0	23	51·9	31·5	20·4	36·0	5	7·5	15	82·2	35·4	. . .
Fulton,	McConnellsburg,	875	. . .	. . .	. . .	42·6	74·0	1	18·0	22, 23	53·1	34·4	18·7	40·0	1	5·0	28	84·0	38·0	3·14
Huntingdon,	Huntingdon— The Normal College,	690	. . .	. . .	. . .	41·8	77·0	1	12·5	23	50·3	32·6	17·7	45·0	1	5·0	26	. . .	. . .	2·95
Indiana,	Indiana— State Normal School,	1,350	. . .	. . .	. . .	43·3	73·0	1	16·0	22	50·9	33·3	17·6	38·0	4	2·0	28	85·0	39·2	2·75
Lackawanna,	Scranton,	750	. . .	. . .	. . .	42·0	70·0	2, 9, 10	13·0	22	50·8	31·7	19·1	31·0	2	6·0	29	82·1	37·4	4·36
Lancaster,	Lancaster— Franklin and Marshall College,	413	30·149	30·723	29·437	44·1	75·0	6	17·0	22, 23	51·1	35·0	16·1	30·5	13	7·5	8	79·7	38·4	2·07
Lawrence,	New Castle,	932	. . .	. . .	. . .	43·2	75·0	1	17·0	22	50·5	31·8	18·7	38·0	1	4·0	28	90·1	40·5	3·99
Lebanon,	Lebanon,	480	30·172	30·751	29·461	43·2	74·3	6	16·8	22	51·7	34·7	17·0	36·2	1	5·7	28	84·2	38·6	3·46
Luzerne,	Drifton— Drifton Hospital,	1,655	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
McKean,	Smethport,	1,500	. . .	. . .	. . .	39·3	74·0	1	10·0	23	48·2	30·0	18·2	. . .	. . .	. . .	. . .	. . .	. . .	4·01
Mercer,	Greenville— Thiel College,	1,000	30·061	30·570	29·510	35·3	73·6	1	16·0	21	44·8	32·6	12·2	33·6	4	3·6	30	82·8	30·2	5·17
Montgomery,	Pottstown,	150	. . .	. . .	. . .	46·0	74·0	2	18·0	23	53·0	39·3	13·7	32·0	1	2·0	3	77·5	57·8	3·42
Northampton,	Bethlehem,	360	30·109	30·707	29·407	45·0	73·0	6	14·0	23	52·0	36·0	16·0	35·0	2	5·0	29	78·0	38·0	3·82
Northumberland,	Shamokin,	733	. . .	. . .	. . .	47·9	75·0	1, 2	25·0	26	57·6	37·4	20·2	. . .	. . .	. . .	. . .	. . .	. . .	1·99
Perry,	New Bloomfield,	400	. . .	. . .	. . .	42·3	64·0	6	14·0	23	51·6	32·4	19·2	41·0	4	5·0	29	. . .	. . .	2·89
Philadelphia,[1]	Philadelphia,	117	30·153	30·760	29·330	45·8	75·0	6	18·0	23	54·3	40·4	13·9	25·0	1	5·9	25	76·4	38·3	3·77
Potter,	Coudersport,	1,670	. . .	. . .	. . .	39·3	73·0	2, 3	10·0	23	48·7	30·0	18·7	43·2	2	7·0	11	75·4	34·2	2·10
Schuylkill,	Girardville,	1,000	30·182	30·647	29·641	42·1	70·0	6	11·0	23	49·0	35·0	14·0	30·0	1	7·0	8	. . .	. . .	4·90
Snyder,	Selins Grove,	445	. . .	. . .	. . .	44·7	73·0	6	16·0	23	51·8	37·6	14·2	27·0	1	2·0	30	77·5	37·4	2·40
Somerset,	Somerset,	2,250	. . .	. . .	. . .	39·0	72·0	1	15·0	26	48·4	31·0	17·4	36·0	1	6·0	27	89·1	36·3	2·74
Sullivan,	Eagles Mere,	2,060	30·189	30·767	29·699	37·0	65·0	10	4·0	23	42·3	29·7	12·6	26·0	10	4·0	30	83·0	31·5	6·22
Susquehanna,	Montrose,	1,656	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Tioga,	Wellsboro,	1,327	. . .	. . .	. . .	37·2	76·0	2	6·0	23	50·1	30·5	19·6	9·3	. . .	2·4	. . .	83·6	40·0	3·68
Venango,	Franklin,	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Warren,	Columbus,	1,410	. . .	. . .	. . .	40·6	74·0	1	12·0	23	47·7	33·4	14·3	40·0	14	1·0	10	. . .	. . .	3·81
Wayne,	Dyberry,	1,100	. . .	. . .	. . .	37·6	72·0	2	8·0	23	47·8	26·6	21·2	37·0	1	3·0	30	. . .	. . .	4·61
Wayne,	Honesdale,	1,000	. . .	. . .	. . .	38·0	67·5	10	9·0	23	45·6	30·3	15·3	34·0	2	4·0	16	. . .	. . .	3·97
Westmoreland,	Greensburg,	1,075	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
York,[1]	York,	385	30·156	30·778	29·560	44·0	76·0	6	20·0	22, 23	53·1	35·0	17·2	40·0	1	8·0	28	76·4	36·9	2·68

[1] Observations taken at 8 A. M. and 8 P. M. [2] Observations taken at 12 Noon.

NTARY OBSERVERS OF THE PENNSYLVANIA STATE WEATHER SERVICE FOR NOVEMBER, 1888.

TEMPERATURE.									PRECIPITATION.				NUMBER OF DAYS.			
		DAILY RANGE.														
Mean of Maximum.	Mean of Minimum.	Mean.	Greatest.	Date.	Least.	Date.	Relative Humidity.	Dew Point.	Total Inches.	Total Snowfall During Month.	Depth of Snow on Ground at End of Month.	Number of Days Rainfall.	Clear.	Fair.	Cloudy.	PR
52·3	38·3	14·0	27·1	13	5·5	29	73·6	35·8	3·57	. . .	. . .	19	8	6	16	N
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	
50·7	31·5	19·2	44·0	1	4·0	28	75·7	32·9	3·01	2·00	. . .	10	9	7	14	S
52·4	34·2	18·2	32·5	1	6·5	27	90·5	40·9	4·06	1·25	. . .	13	11	5	14	N
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. .	. . .	. . .	. . .	. . .	
54·8	36·0	18·8	29·0	7	7·0	28	69·6	36·2	2·45	. . .	. . .	. . .	. . .	. . .	. . .	
52·0	30·0	22·0	44·0	1	7·0	29	90·0	39·0	3·05	2·00	. . .	9	9	8	13	
48·4	33·2	15·2	32·5	1	4·5	8	82·6	34·5	3·27	3·00	. . .	15	10	3	17	N
51·1	34·2	16·9	36·0	1	3·0	15	84·4	37·7	3·71	. . .	. . .	11	9	9	12	S
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	
50·1	30·0	20·1	42·0	3	5·0	3	77·0	33·0	2·56	·50	. . .	10	8	11	11	
48·1	30·0	18·1	30·0	1	7·0	8	77·0	36·5	2·71	1·08	. . .	11	9	7	14	
49·8	29·1	20·7	40·0	1	5·0	28	. . .	. . .	3·57	2·00	. . .	12	9	9	12	S
51·0	36·9	14·1	25·5	1	7·5	28	72·0	35·5	3·94	1·00	. . .	16	9	13	8	
53·0	34·4	18·6	38·5	1	8·0	29	. . .	. . .	3·36	1·00	. . .	10	10	6	14	
46·0	33·0	13·0	26·0	4	2·0	28	. . .	. . .	. . .	4·25	1·00	. . .	10	8	12	S
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	
46·2	37·0	9·2	34·0	14	2·0	8	. . .	. . .	3·66	4·00	2·00	15	10	8	12	
49·1	30·5	18·6	38·0	1	6·0	27	. . .	. . .	4·59	2·50	. . .	13	13	3	14	
54·0	37·0	17·0	43·0	1	4·0	3	71·0	36·8	3·79	1·00	. . .	14	9	9	12	
55·3	37·5	17·8	32·0	4	5·0	30	. . .	. . .	3·22	·30	. . .	13	11	6	13	
52·9	36·6	16·3	35·5	1	3·5	30	73·2	35·5	2·88	3·00	. . .	11	7	12	11	
50·4	36·8	13·6	28·0	1	4·8	. . .	76·7	35·5	2·30	·50	. . .	11	7	7	16	N
53·1	33·7	19·4	27·3	4	7·0	28	76·2	38·6	4·13	·25	. . .	9	4	8	18	
50·1	37·1	13·0	24·3	4	4·0	30	. . .	. .	3·38	. . .	. . .	17	3	6	21	
52 8	35·7	17·1	33·0	1	6·0	25	78·0	39·0	3·36	3·25	·50	11	9	9	12	S
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	
51·9	31·5	20·4	36·0	5	7·5	15	82·2	35·4	. . .	. . .	. . .	. . .	13	2	15	
53·1	34·4	18·7	40·0	1	5·0	28	84·0	38·0	3·14	1·00	. . .	8	9	9	12	
50·3	32·6	17·7	45·0	1	5·0	26	. . .	. . .	2·95	3·35	. . .	9	15	3	12	
50·9	33·3	17·6	38·0	4	2·0	28	85·0	39·2	2·75	2·50	1·00	12	8	6	16	
50·8	31·7	19·1	31·0	2	6·0	29	82·1	37·4	4·36	3·00	. . .	11	11	13	6	
51·1	35·0	16·1	30·5	13	7·5	8	79·7	38·4	2·97	1·00	. . .	9	7	11	12	
50·5	31·8	18·7	38·0	1	4·0	28	90·1	40·5	3·99	·11	·10	9	6	7	17	S
51·7	34·7	17·0	36·2	1	5·7	28	84·2	38·6	3·26	1·00	. . .	14	10	6	14	N
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	
48·2	30·0	18·2	. . .	. . .	. . .	. . .	. . .	. . .	4·01	. . .	. . .	10	11	5	14	S
44·8	32·6	12·2	33·6	4	3·6	30	82·8	30·2	5·17	2·00	. . .	17	7	7	16	S
53·0	39·3	13·7	32·0	1	2·0	3	77·5	57·8	3·42	·50	. . .	9	12	8	10	N
52·0	36·0	16·0	35·0	2	5·0	29	78·0	38·0	3·82	2·00	. . .	8	. . .	. . .	. . .	N
57·6	37·4	20·2	. . .	. . .	. . .	. . .	. . .	. . .	1·99	. . .	. . .	. . .	. . .	. . .	. . .	N
51·6	32·4	19·2	41·0	4	5·0	29	. . .	. . .	2·89	3·00	. . .	7	14	4	12	
54·3	40·4	13 9	25·0	1	5·9	25	76·4	38·3	3·77	·50	. . .	14	9	1	20	N
48·7	30·0	18·7	43·2	2	7·0	11	75·4	34·2	2·10	2·00	·50	8	4	8	18	
49·0	35·0	14·0	30·0	1	7·0	8	. . .	. . .	4·90	3·00	1·00	8	12	8	10	N
51·8	37·6	14·2	27·0	1	2·0	30	77·5	37·4	2·40	2·25	.	5	10	11	9	N
48·4	31·0	17·4	36·0	1	6·0	27	89·1	36·3	2·74	2·00	1·50	9	11	2	17	S
42·3	29·7	12·6	26·0	10	4·0	30	83·0	33·5	6·22	10·50	4·75	13	5	14	11	S
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	
50·1	30·5	19·6	9·3	. . .	2·4	. . .	83·6	40·0	3·68	6·55	·50	14	5	6	19	
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	
47·7	33·4	14·3	40·0	14	1·0	10	. . .	. . .	3·81	. . .	1·00	16	11	2	17	S
47·8	26·6	21·2	37·0	1	3·0	30	. . .	. . .	4·61	3·00	. .	10	10	7	13	N
45·6	30·3	15·3	34·0	2	4·0	16	. . .	. . .	3·97	2·00	. . .	12	. . .	. . .	. . .	
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	
53·1	35·0	17·2	40·0	1	8·0	28	76·4	36·9	2·68	2·50	. . .	8	13	9	8	N

Days.	Cloudy.	Wind. Prevailing Direction. 7 A. M.	2 P. M.	9 P. M.	Observers.
	16	NW	NW	NW	Oscar D. Stewart, Sgt. Sig. Corps.
	...	...	...	...	Smith Curtis.
	14	SW	SW	SW	Rev. A. Thos. G. Apple.
	14	NW	NW	NW	C. M. Dechant, C.E.
	...	...	...	...	Prof. J. H. Rohrbach.
	...	...	...	...	Dr. Charles B. Dudley.
	13	W	W	W	Prof. J. A. Stewart.
	17	NW	NW	NW	Charles Beecher.
	12	SW	SW	NW	J. L. Heacock.
	...	...	...	...	J. E. Forsythe.
	...	...	...	...	E. C. Lorentz.
	11	W	W	W	T. B. Lloyd
	14	W	W	W	Prof. Wm. Frear.
	19	SW	SW	SW	Geo. H. Dunkle.
	8	N	NW	NW	Jesse C. Green, D.D.S.
	14	W	W	W	W. T. Gordon.
	12	SW	SW	SW	Rev. W. W. Deatrick, A.M.
	...	...	...	...	C. M. Thomas, B.S.
	13	W	W	W	Nathan Moore.
	14	W	W	W	Prof. John A. Robb.
	13	N	NW	NW	Robert M. Graham.
	13	S	S	W	Prof. J. H. Montgomery.
	11	W	W	W	J. E. Pague.
	16	NE	NE	NE	Frank Ridgway, Sgt. Sig. Corps.
	18	N	N	N	Prof. Susan J. Cunningham.
	21	S	S	S	Peter Wood, Sgt Sig. Corps.
	12	SW	SW	SW	Wm. Hunt.
	...	...	...	...	Robert L. Haslet.
	15	...	...	...	P. C. Richardson.
	22	...	...	...	Thomas F. Sloan.
	12	W	W	W	Prof. W. J. Swigart.
	16	W	W	W	Prof. Albert E Maltby.
	6	N	NE	N	J F. Baumeister.
	12	W	W	W	A M. Schmidt, A.B.
	17	SE	SE	SE	Wm. T. Butz.
	14	NE	NE	NE	George W. Hayes. C.E., Ph G.
	...	...	...	...	H D. Miller, M.D.
	14	SW	W	W	Armstrong & Brownell.
	16	SW	SW	S	Prof S. H. Miller.
	10	NW	W	W	Charles Moore, D.D.S.
	...	NE	NW	W	Lerch & Rice.
	...	NW	NW	NW	G. R. Hanley.
	12	W	W	W	Frank Mortimer.
	20	NW	NW	NW	Luther M. Dey, Sgt. Sig. Corps.
	18	W	W	W	C. L. Peck.
	10	NW	NW	NW	E. C Wagner.
	9	NW	NW	NW	J M Boyer,
	17	SW	SW	SW	W. M. Schrock.
	11	SW	NW	SW	E. S. Chase.
	...	...	...	...	A. H. Berlin.
	19	N	NW	N	H. D. Deming.
	...	...	...	...	Prof. N. P. Kinsley.
	17	SW	SW	SW	Wm. Loveland.
	13	NW	NW	NW	Theodore Day.
	...	...	...	...	John Torrey.
	...	...	...	...	H. S. Brunot.
	8	NE	...	NW	Mrs. L. H. Grenewald.

T. F. Townsend, *Sergeant Signal Corps, Assistant.*

	Erie.
1	. .
2	'05
3	'30
4	. .
5	. .
6	'34
7	. .
8	'51
9	'28
10	'46
11	'10
12	. .
13	. .
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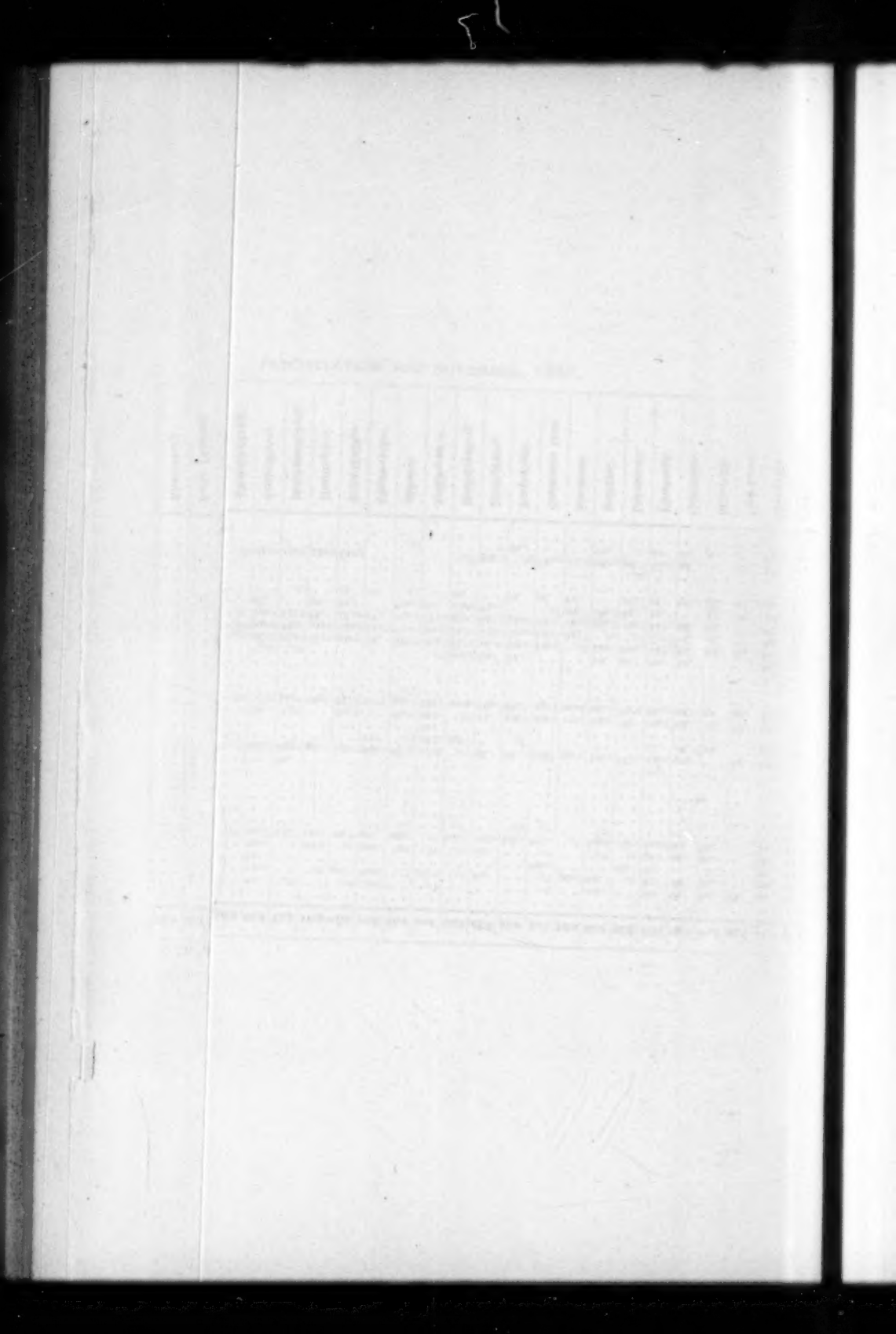
26	'15
27	'17
28	'05
29	'30
30	'16
31	. .
	3'38

PRECIPITATION FOR NOVEMBER, 1888.

	Erie.	Greenville.	New Castle.	Meadville.	Columbus.	Pittsburgh.	Uniontown.	Indiana.	Somerset.	Grampian Hills.	Emporium.	Phillipsburg.	Hollidaysburg.	Smethport.	Altoona.	Charlesville.	State College.	Huntingdon.	McConnellsburg.	Lock Haven.	Chambersburg.	New Bloomfield.	Carlisle.	Wellsboro.	York.	Harrisburg.	Selins Grove.	Wysox.	Eagles Mere.	Catawissa.	Shamokin.	Girardville.	Lebanon.	Lancaster.	Reading.	Scranton.	Pottstown.	West Chester.	Coatesville.	Dyberry.	Honesdale.	Bethlehem.	Quakertown.	Swarthmore.	Philadelphia.	Coudersport.	Scisholtzville.	Frederick.	Ottsville.	Smith's Corner.	Doylestown.	Lansdale.	Forks of Neshan'y.	Germantown.	Point Pleasant.	Rimersburg.
1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	.03	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	.08	..	..
2	.05	.19	..	.15	.03	.07	..	.04	..	..	.19	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	.05	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
3	.30	.33	.75	..	.38	.33	.16	.40	.15	.43	..	.08	..	..	..	..	.15	.06	.11	.10	..	.15	.10	.08	.08	.08	..	..	..	.03	.10	.18	.08	.08	.06	..	.07	.04	.05	.36	.25	.03	.11	.02	.01	.10	.05	.08	.35	.11	..	..	.03	..	..	..
4	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	.21	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
5	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
6	.34	.86	.71	.58	.56	.32	.32	..	.14	.32	.39	..	.03	..	..	.02	.11	..	..	..	..	..	..	.16	..	..	..	.21	.43	..	..	..	..	..	..	.07	..	.01	..	..	.20	.03	..	..	.02	.01	.30	..	..	..	..	..	..	.10	.03	..	..
7	..	.09	.42	.15	..	.24	.12	.40	.04	..	..	..	..	..	..	..	.14	.06	..	.39	..	..	..	..	..	..	..	.06	..	.02	.08	..	.03	..	.03	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
8	.51	.34	..	.39	.52	.54	.21	.68	.25	.77	.58	.75	.28	.45	.27	.40	.31	.33	.15	.01	..	.20	.15	.19	..	.16	..	.15	.50	.40	.26	.78	.16	.06	.15	.24	.20	.10	.14	..	.30	..	.12	.02	.04	.20	..	..	..	..	..	..	..	..	..	..
9	.28	.84	..	.50	.10	.17	..	..	.19	.24	.09	.25	.25	.25	.15	.27	.15	.16	.41	.16	..	.33	.25	.50	.21	.28	.30	.10	1.00	.32	.45	.62	.32	.13	.31	.74	.35	.24	.30	.52	.15	.59	.39	.14	.12	..	..	.28	..	.28	..	..	..	..	..	..
10	.46	.44	.63	.49	.75	.25	.04	.25	..	.13	.05	.71	.35	.30	.48	.23	.18	.35	.51	.30	..	.02	.15	.16	.10	.18	..	.34	.80	.17	.10	.25	.08	.23	.40	.68	.40	.57	.41	.80	.85	.35	.49	.96	1.20	..	1.15	.34	.48	.50	.74	.70	.49	1.03	..	..
11	.10	.04	..	..	.12	.02	.07	.05	..	..	.13	.03	.02	..	..	..	..	..	..	..	..	..	.12	.10	..	..	..	..	.05	.07	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	.50	..	..	..	..	..	..	..	..	..	..
12	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
13	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
14	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	.27	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
15	..	.19	.28	.10	.12	.59	1.33	.60	1.00	.82	.43	.93	1.00	.35	.88	1.10	.74	.90	.78	1.02	..	.90	.95	.84	.89	.75	..	.64	.98	1.02	.80	1.39	1.04	1.20	1.27	.97	1.00	1.25	1.05	1.11	1.17	.39	1.23	1.56	1.41	.40	1.51	1.03	1.11	1.34	..	.85	..	1.32	..	..
16	.21	.95	.33	.31	.20	.20	.35	.02	.21	.22	.22	.12	..	.40	.02	..	.03	..	..	.15	..	..	.01	.60	..	.02	..	.14	.26	.15	..	.09	.02	.02	.06	..	.05	.06	.07	..	.02	.64	.08	..	.05	.20	..	.05	.18	.07	1.44	.15	1.44	.06	..	..
17	..	..	..	..	..	..	..	..	..	..	..	..	..	.10	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
18	.13	.25	..	.10	.20	.17	..	..	..	..	..	..	.86	.40	..	.12	..	..	..	..	..	..	..	..	..	..	..	.10	.36	.40	..	.85	..	..	..	..	..	..	..	..	..	..	..	..	..	..	.05	..	..	..	..	..	..	..	..	..
19	.17	.19	.29	..	.28	.12	.33	.04	.68	.55	.35	.38	..	1.20	.59	.69	.63	.78	.89	.50	..	.85	.69	.20	1.12	.72	1.50	.08	.94	.28	..	..	.93	.96	1.02	.55	1.00	1.12	.98	.76	.68	1.16	1.07	.97	.67	.30	1.16	.82	.79	.85	.75	.91	.65	.77	..	..
20	..	..	..	..	..	.02	..	..	..	..	..	..	..	..	..	..	..	..	.04	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	.02	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
21	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
22	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
23	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
24	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	.01	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
25	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	.21	..	.15	..	.36	.01	..	.05	..	..	.05	.02	.15	.31	.40	..	..	.01	..	..	..	..	..	..	..	..	..	..
26	.15	.15	..	.05	.12	.25	.31	.15	..	.14	.13	.01	.11	..	.02	.08	.21	.21	.25	.10	..	.44	.35	.75	.25	.14	..	.88	.40	.54	.20	.38	.42	.24	.62	.40	.35	.32	.32	.16	.07	..	.10	.40	.13	.10	..	.12	.56	..	.72	..	.48	.61	.52	..	..
27	.17	.09	..	.10	.08	.16	..	..	..	..	..	.13	..	..	..	.06	..	.09	..	.90	..	..	.10	.12	.02	.06	.20	.01	.34	.02	..	..	.05	..	.05	.21	..	.05	..	..	.09	..	..	..	.03	..	.18	..	..	.70	..	..	..	..	..	..
28	.05	.09	..	..	.11	.05	.12	..	..	.04	..	..	..	..	..	..	..	..	..	.14	..	..	..	..	..	..	..	..	..	..	..	..	.02	..	.11	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
29	.30	.06	..	.25	.09	.04	..	.10	.08	..	..	.04	..	.30	..	.04	.06	..	..	.11	..	..	.01	..	.01	..	.20	.03	.13	.22	..	..	.03	.05	.03	.18	..	.04	.02	..	.05	.06	.09	..	.02	..	.04	.08	..	.05	.09	..	.48	.61	.52	..	..
30	.16	.07	.47	.05	.15	.03	..	.02	..	..	..	..	..	..	..	..	..	..	..	.04	..	..	..	.05	..	.01	.20	..	.03	..	..	..	.07	..	.01	..	..	.03	..	.55	..	..	..	.01	.04	.07	..	..	..	..	..	..	.22	.06	.09	..	..
31	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	3.38	5.17	3.88	3.22	3.81	3.57	3.36	2.75	2.74	3.66	2.56	3.57	3.05	4.01	2.45	3.01	2.71	2.94	3.14	4.59	2 88	2 89	2.88	3.68	2.68	2.30	2.40	3.27	6.22	3.79	1.99	4.90	3.26	2.97	4.06	4.36	3.42	3.94	3.36	4.61	3.97	3.82	3.71	4.13	3 77	2.10	4 14	2.80	3.47	3.90	3.74	3.41	3.31	3.87	3.55	4.25

T. F. T.



delphia, 14th; Eagles Mere, 14th, 17th; Wellsboro, 14th; Dyberry, 14th; York, 14th.

Polar Banas.—Coudersport, 8th.

WEATHER SIGNALS.

Displayman.	*Station.*
U. S. Signal Office,	Philadelphia.
Wanamaker & Brown,	"
Pennsylvania Railroad Company,	"
Continental Brewing Company,	"
Samuel Simpson,	"
B T. Babbitt,	"
Western Meat Company,	"
Neptune Laundry,	"
Chester Oil Company,	Chester.
C. W. Buckhart,	Shoemakerville.
A. N. Lindenmuth,	Allentown.
C. B. Whitehead,	Bradford.
Capt. Geo. R. Guss,	West Chester.
Werner & Son,	Emporium.
C. E. Lenhart,	Latrobe.
Thomas F. Sloan,	McConnellsburg.
J. H. Fulmer,	Muncy.
W. T. Butz,	New Castle.
S. W. Morrison,	Oxford.
Capt. A. Goldsmith,	Quakertown.
J. L. Morrison,	Sharon.
Wm. A. Engel,	Shenandoah.
Wm. Schrock,	Somerset.
Postmaster,	Meadville.
Frank Ross,	Oil City.
Lerch & Rice,	Bethlehem.
John W. Aitken,	Carbondale.
Signal Office,	Erie.
J. R. Raynsford,	Montrose.
E. P. Wilbur & Co.,	South Bethlehem.
Agricultural Experiment Station,	State College.
Signal Office,	Pittsburgh.
E. H. Baker,	Williamsport.
New Era,	Lancaster.
State Normal School,	Clarion.
Clarion Collegiate Institute,	Rimersburg.
E. S. Chase,	Eagles Mere.
Thiel College,	Greenville.
D. G. Hurley,	Altoona.
Armstrong & Brownell,	Smethport.
J. E. Forsythe,	Butler.

Displayman.	*Station.*
James H. Fones,	Tionesta.
Wister, Hacker & Savage,	Germantown.
W. J. Thompson & Co.,	Clifton Heights.
Steward M. Dreher,	Stroudsburg.
State Normal School,	Millersville.
E. C. Wagner,	Girardville.
Hartford P. Brown,	Rochester.
L. H. Grenewald,	York.
J. E. Pague,	Carlisle.
C. L. Peck,	Coudersport.
H. D. Miller,	Drifton.
Smith Curtis,	Beaver.
M. Tannehill,	Confluence.
S. C. Burkholder,	Pollock.
Robt. M. Graham,	Catawissa.
Henry F. Bitner,	Millersville.
A. J. Edelman,	Pottstown.
A. M. Wildman,	Langhorn.
N. E. Graham,	East Brady.
B. F. Gilmore,	Chambersburg.
Frank M. Morrow,	Altoona.
A. Simon's Sons,	Lock Haven.
E. W. McArthurs,	Meadville.
J. K. M. McGovern,	Lock No. 4.
A. M. Row,	Clearfield.

PENNSYLVANIA STATE WEATHER SERVICE.

MONTHLY WEATHER REVIEW

FOR DECEMBER, 1888.

Prepared under the Direction of the Committee on Meteorology of the FRANKLIN INSTITUTE.

HALL OF THE FRANKLIN INSTITUTE,

PHILADELPHIA, December 31, 1888.

TEMPERATURE.

The mean temperature for December, determined from the tri-daily observations, was 32°.6 which is slightly above the normal.

The mean daily maximum and minimum, 40° and 25° respectively, give a monthly mean of 32°.5. The highest temperatures reported were Pittsburgh, 62°.1; Tionesta, 62°.0; Meadville, 61°.0 and Philadelphia, 61°.0. The lowest were Columbus, minus 10°; Clarion, minus 9° and Greenville, minus 4.

The warmest period of the month was on the 26th and the coldest on the 22d.

BAROMETER.

The mean pressure for the state, 30.10, was about normal. The highest occurred on the 30th and the lowest on the 17th. The latter was accompanied by heavy rains throughout the state.

PRECIPITATION.

The average rainfall, 3·14, is slightly above the normal. Some deficiencies occurred in the western part of the state. Most of the eastern counties received an excess. More than half of the monthly total for the middle and eastern parts of the state fell on the 17th, causing freshets.

Flurries of snow were frequent. Many stations report only a "trace." The greatest totals for the month are, Meadville, 21 inches; Eagles Mere, 20 inches; Wellsboro, 13 inches; Tionesta, 13 inches; Girardville, 11 inches; Somerset, 7 inches; Uniontown, 7 inches and Columbus 6 inches. All of the snows melted rapidly and none remained on the ground at the end of the month.

WIND AND WEATHER.

No severe gales passed over the state during the month. The weather has been favorable for winter grain, which is reported in good condition.

Average number.—Rainy days, 9; clear days, 8; fair days, 8; cloudy days, 15.

Prevailing wind direction, northwest.

MISCELLANEOUS PHENOMENA.

Snow.—Charlesville, 3d, 4th, 6th, 13th, 21st; Reading, 1st, 4th, 13th, 21st; Hollidaysburg, 3d, 4th, 5th, 21st, 31st; Wysox, 4th, 5th; Emporium, 4th, 9th, 14th, 16th, 21st, 27th, 28th, 31st; State College, 4th, 9th, 18th, 19th; West Chester, 4th, 5th, 6th, 13th, 19th, 21st; Coatesville, 4th, 19th; Grampian Hills, 4th, 8th, 13th, 19th; Lock Haven, 4th, 9th, 18th, 28th; Carlisle, 4th; Tionesta, 1st, 4th, 9th, 14th, 17th, 19th, 28th; Indiana, 3d, 4th, 12th, 14th, 16th, 17th, 18th, 27th; Scranton, 9th, 28th; Lancaster, 1st, 4th, 13th; New Castle, 4th, 14th, 19th; Drifton, 4th, 9th, 17th, 19th; Smethport, 1st, 4th, 5th, 8th, 20th; Greenville, 1st, 3d, 4th, 5th, 6th, 8th, 9th, 12th, 13th, 14th, 17th, 18th, 19th, 20th, 21st, 22d, 25th, 26th, 28th, 31st; New Bloomfield, 4th; Philadelphia, 1st, 4th, 6th, 13th, 19th; Girardville, 7th, 9th, 17th, 18th; Selins Grove, 1st, 4th, 13th, 19th, 21st; Somerset, 1st, 4th, 6th, 14th, 18th, 19th, 21st; Eagles Mere, 1st, 4th, 5th, 6th, 8th, 13th, 16th, 18th, 21st, 27th; Wellsboro, 1st, 4th, 5th, 8th, 9th, 13th, 18th, 21st; Columbus, 1st, 4th, 5th, 6th, 8th, 13th, 18th, 19th, 20th, 27th; Dyberry, 1st, 3d, 4th, 5th, 6th, 8th, 9th, 12th, 13th, 18th, 19th, 20th, 21st, 22d, 28th; Westtown, 4th, 19th.

Coronæ.—Charlesville, 7th; Indiana, 7th; Lebanon, 7th, 12th, 14th, 15th, 20th, 21st, 25th; Somerset, 20th, 21st, 25th; Dyberry, 15th, 29th.

Solar Halos.—Charlesville, 22d, 26th; Somerset, 12th, 15th; Eagles Mere, 7th, 30th; Wellsboro, 6th, 30th; Dyberry, 7th.

Lunar Halos.—Charlesville, 7th, 12th, 15th, 19th, 26th; Wysox, 26th; Quakertown, 12th, 15th; West Chester, 15th; Coatesville, 15th; Harrisburg 7th, 12th, 15th, 27th; Lancaster, 12th, 15th; Lebanon, 11th, 12th, 15th; Eagles Mere, 15th; Dyberry, 29th; York, 12th.

Monthly Summary of Reports by Voluntary Observers of the Pennsylvania State Weath

County.	Station.	Elevation above Sea Level (feet).	Barometer.			Temperature.												Relative Humidity.	Dew Point.	Total Inches.
							Maximum.		Minimum.				Daily Range.							
			Mean.	Highest.	Lowest.	Mean.	Highest.	Date.	Lowest.	Date.	Mean of Maximum.	Mean of Minimum.	Mean.	Greatest.	Date.	Least.	Date.			
Allegheny,[1]	Pittsburgh,	847	30·093	30·540	29·410	35·0	62·1	26	12·2	22	42·0	29·6	12·4	28·1	15	3·3	9	71·1	25·9	1·66
Beaver,	Beaver,	821	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Bedford,	Charlesville,	1,300	. . .	. . .	. . .	32·3	57·5	25	8·0	22	41·0	24·3	16·7	40·0	24	3·0	3	73·0	22·9	1·63
Berks,[1]	Reading,	304	30·092	30·602	29·439	31·7	57·5	26	7·5	22	42·5	25·2	17·3	34·5	24	8·0	9	. . .	. . .	3·44
Berks,	Kutztown— Keystone State Normal School,	540	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Blair,[2]	Altoona,	1,181	. . .	. . .	. . .	37·6	58·0	26	9·0	22, 23	45·7	29·6	16·1	40·0	22	9·0	4	72·1	27·5	1·44
Blair,	Hollidaysburg,	947	. . .	. . .	. . .	33·0	59·0	25	7·0	22, 23	42·0	22·0	20·0	43·0	23	7·0	28	74·0	25·0	1·68
Bradford,	Wysox,	718	. . .	. . .	. . .	30·5	55·5	26	5·5	22	36·3	23·4	12·9	30·0	23	3·5	9	79·7	26·7	2·51
Bucks,	Quakertown,	536	30·080	30·610	29·240	32·5	56·0	25	6·7	22	43·3	23·1	20·2	35·0	24	7·0	10	82·6	27·0	4·75
Butler,	Butler,	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Cambria,	Johnstown,	1,184	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Cameron,	Emporium,	1,030	. . .	. . .	. . .	30·7	56·0	26	— 1·0	22	38·5	21·4	17·1	36·0	24	5·0	3	80·0	25·2	2·94
Centre,	State College— Agricultural Experiment Station,	1,191	30·111	30·646	29·548	32·2	48·5	25, 26	1·0	22	37·7	20·6	17·1	35·0	24	6·0	11	89·5	28·8	2·07
Centre,	Phillipsburg,	1,350	. . .	. . .	. . .	25·8	55·0	25	0·0	22	38·0	21·5	16·5	44·0	7	5·0	10	. . .	. . .	2·28
Chester,	West Chester,	455	30·070	30·534	28·972	34·2	55·5	25	9·0	22	42·0	26·9	15·1	26·0	24	5·0	9	68·0	24·2	4·97
Chester,	Coatesville,	380	. . .	. . .	. . .	32·4	60·0	25, 26	9·0	22	44·18	24·0	20·8	38·5	24	7·0	10	. . .	. . .	5·25
Chester,	Westtown,	. . .	30·155	30·680	29·120	33·0	60·0	27	12·0	22	43·1	27·2	15·9	28·0	25	6·0	11	. . .	. . .	4·06
Clarion,	Rimersburg,	1,500	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Clarion,	Clarion— State Normal School,	1,530	. . .	. . .	. . .	30·0.	55·0	26	— 9·0	21	36·2	23·8	12·4	29·5	31	5·0	9	83·6	24·5	2·75
Clearfield,	Grampian Hills,	1,450	. . .	. . .	. . .	29·1	50·0	26	. . .	22	34·4	23·1	11·3	32·0	23	2·0	1	. . .	. . .	2·89
Clinton,	Lock Haven,	560	. . .	. . .	. . .	31·9	55·0	26	5·0	22	38·3	21·5	14·8	30·0	24	5·0	3	. . .	. . .	3·31
Columbia,	Catawissa,	491	. . .	. . .	. . .	35·7	60·0	25	9·0	22	41·5	28·7	12·8	34·0	24	3·0	10	. . .	. . .	3·97
Crawford,	Meadville— Allegheny College,	1,050	30·143	30·538	29·620	31·8	61·0	26	7·0	14	44·0	28·9	15·1	28·0	14	5·5	1	76·5	27·8	5·30
Cumberland,	Carlisle,	480	. . .	. . .	. . .	34·8	56·0	25	13·0	22	41·6	28·9	12·7	29·5	25	1·0	10	71·2	26·0	2·77
Dauphin,[1]	Harrisburg,	361	30·100	30·600	29·070	33·4	54·0	26	11·0	22	40·4	28·2	12·2	25·2	24	2·5	6	73·2	25·4	2·50
Delaware,	Swarthmore— Swarthmore College,	190	30·092	30·601	28·945	33·7	58·0	26	11·2	22	41·1	26·3	14·8	24·0	23	5·3	11	77·7	27·3	3·65
Erie,[1]	Erie,	681	30·060	30·560	29·500	33·0	55·0	26	8·0	22	38·2	28·3	9·9	27·0	15	3·0	12	. . .	. . .	1·77
Fayette,	Uniontown,	1,000	30·092	30·580	29·340	35·5	62·0	26	6·0	22	42·1	26·7	15·4	35·0	23	5·0	2	. . .	. . .	2·67
Forest,	Tionesta,	1,058	. . .	. . .	. . .	31·9	56·0	26	— 2·0	22	40·1	24·7	15·4	32·0	24	3·0	2	. . .	. . .	2·25
Franklin,[1]	Chambersburg— Wilson Female College,	618	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Fulton,	McConnellsburg,	875	. . .	. . .	. . .	33·5	60·0	25	11·0	22	43·9	26·7	17·2	39·0	24	4·0	17	77·3	27·2	2·70
Huntingdon,	Huntingdon— The Normal College,	650	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Indiana,	Indiana— State Normal School,	1,350	. . .	. . .	. . .	33·3	60·0	26	9·0	20	38·7	25·5	13·2	24·0	24	5·0	2	83·5	28·6	2·52
Lackawanna,	Scranton,	750	. . .	. . .	. . .	35·8	55·0	26	4·0	21	42·2	22·1	20·1	41·0	27	3·0	1	84·0	28·2	2·35
Lancaster,	Lancaster— Franklin and Marshall College,	413	30·119	31·288	29·939	34·8	59·0	25	9·0	21	43·0	25·0	18·0	39·0	25	6·5	10	68·7	25·1	3·59
Lawrence,	New Castle,	932	. . .	. . .	. . .	33·5	57·0	26, 27	2·0	22	39·4	24·7	14·7	35·0	23	3·0	13	88·0	29·6	2·45
Lebanon,	Lebanon,	480	30·095	30·810	28·955	33·3	57·5	24	10·3	22	41·3	26·1	15·2	40·1	24	3·7	10	79·6	28·3	3·77
Luzerne,	Drifton— Drifton Hospital,	1,655	. . .	. . .	. . .	30·0	57·0	25, 27	0·0	22	39·9	22·9	17·0	33·0	23	8·0	31	. . .	. . .	2·05
McKean,	Smethport,	1,500	. . .	. . .	. . .	31·1	56·0	26	4·0	22	37·3	24·9	12·4	39·0	23	4·0	10	. . .	. . .	2·21
Mercer,[1]	Greenville— Thiel College,	1,000	30·031	30·489	29·441	36·3	55·6	26	— 4·0	22	38·0	25·5	12·5	35·6	25	4·9	1	87·1	26·6	1·61
Montgomery,	Pottstown,	150	. . .	. . .	. . .	35·0	58·0	27	11·0	22	42·0	25·0	17·0	32·0	24	5·0	10	71·0	26·5	4·80
Northampton,	Bethlehem,	360	30·006	30·557	29·467	35·0	55·0	25, 26	10·0	22	42·0	26·0	16·0	44·0	27	17·0	22	70·0	27·0	3·59
Northumberland,	Shamokin,	733	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Perry,	New Bloomfield,	400	. . .	. . .	. . .	33·2	58·0	25	9·0	22	42·5	24·7	17·8	39·0	24	6·0	10	. . .	. . .	3·63
Philadelphia,[1]	Philadelphia,	117	30·092	30·640	29·030	35·8	61·0	26	12·0	22	43·8	30·4	13·4	23·6	16	5·2	10	68·8	26·0	3·15
Potter,	Coudersport,	1,670	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Schuylkill,	Girardville,	1,000	30·080	30·560	29·460	32·8	53·0	25, 26	7·0	21	39·2	25·3	13·9	28·0	24	3·0	21	. . .	. . .	4·62
Snyder,	Selins Grove,	445	. . .	. . .	. . .	34·7	52·0	25	9·0	22	39·8	28·8	11·0	30·0	25	3·0	10	76·9	27·9	3·09
Somerset,	Somerset,	2,250	. . .	. . .	. . .	27·1	57·0	26	— 2·0	22	37·1	21·1	16·0	41·0	15	3·0	3	87·1	23·0	2·21
Sullivan,	Eagles Mere,	2,060	30·111	30·622	29·313	25·6	47·0	25	— 4·0	22	29·8	19·3	10·5	23·0	16	3·0	3	80·7	21·2	4·77
Susquehanna,	Montrose,	1,656	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Tioga,	Wellsboro,	1,327	. . .	. . .	. . .	29·3	58·0	26	— 4·0	22	36·1	22·9	13·2	14·7	16	4·2	24	81·1	23·4	5·57
Venango,	Franklin,	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Warren,	Columbus,	1,410	. . .	. . .	. . .	29·2	52·0	26	—10·0	22	34·4	23·9	10·5	38·0	15	1·5	17	. . .	. . .	3·00
Wayne,	Dyberry,	1,100	. . .	. . .	. . .	27·8	53·0	27	— 4·0	22	30·3	20·5	15·8	35·0	23	4·0	9	. . .	. . .	3·40
Wayne,	Honesdale,	1,000	. . .	. . .	. . .	28·0	53·0	27	— 2·0	22	34·0	22·0	12·0	29·0	23	2·0	10	. . .	. . .	3·63
Westmoreland,	Greensburg,	1,075	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
York,[1]	York,	385	30·096	30·640	29·370	33·9	60·0	26	12·0	22	44·3	27·6	16·7	33·0	25	6·0	31	74·6	26·7	3·62

[1] Observations taken at 8 A. M. and 8 P. M. [2] Observations taken at 12 Noon.

BY VOLUNTARY OBSERVERS OF THE PENNSYLVANIA STATE WEATHER SERVICE FOR D

TEMPERATURE.											PRECIPITATION.			
MINIMUM.				DAILY RANGE.										
Lowest.	Date.	Mean of Maximum.	Mean of Minimum.	Mean.	Greatest.	Date.	Least.	Date.	Relative Humidity.	Dew Point.	Total Inches.	Total Snowfall During Month.	Depth of Snow on Ground at End of Month.	Number of Days Rainfall.
2·2	22	42·0	29·6	12·4	28·1	15	3·3	9	71·1	25·9	1·66	. . .	. . .	14
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
8·0	22	41·0	24·3	16·7	40·0	24	3·0	3	73·0	22·9	1·63	. . .	. . .	7
7·5	22	42·5	25·2	17·3	34·5	24	8·0	9	. . .	. . .	3·44	. . .	. . .	6
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
9·0	22, 23	45·7	29·6	16·1	40·0	22	9·0	4	72·1	27·5	1·44	. . .	. . .	5
7·0	22, 23	42·0	22·0	20·0	43·0	23	7·0	28	74·0	25·0	1·68	·06	. . .	7
5·5	22	36·3	23·4	12·9	30·0	23	3·5	9	79·7	26·7	2·51	2·21	. . .	9
6·7	22	43·3	23·1	20·2	35·0	24	7·0	10	82·6	27·0	4·75	. . .	. . .	6
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
1·0	22	38·5	21·4	17·1	36·0	24	5·0	3	80·0	25·2	2·94	6·75	·50	12
1·0	22	37·7	20·6	17·1	35·0	24	6·0	11	89·5	28·8	2·07	1·37	. . .	10
0·0	22	38·0	21·5	16·5	44·0	7	5·0	10	. . .	. . .	2·98	3·75	. . .	14
9·0	22	42·0	26·9	15·1	26·0	24	5·0	9	68·0	24·2	4·97	. . .	. . .	9
9·0	22	44·8	24·0	20·8	38·5	24	7·0	10	. . .	. . .	5·25	·25	. . .	8
12·0	22	43·1	27·2	15·9	28·0	25	6·0	11	. . .	. . .	4·08	. . .	. . .	7
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
9·0	21	36·2	23·8	12·4	29·5	31	5·0	9	83·6	24·5	2·75	. . .	. . .	. . .
. . .	22	34·4	23·1	11·3	32·0	23	2·0	1	. . .	. . .	2·89	7·00	. . .	16
5·0	22	38·3	21·5	14·8	30·0	24	5·0	3	. . .	. . .	3·31	1·25	. . .	8
9·0	22	41·5	28·7	12·8	34·0	24	3·0	10	. . .	. . .	3·97	1·25	. . .	9
7·0	14	44·0	28·9	15·1	28·0	14	5·5	1	76·5	27·8	5·30	21·40	. . .	14
13·0	22	41·6	28·9	12·7	29·5	25	1·0	10	71·2	26·0	2·77	. . .	. . .	7
11·0	22	40·4	28·2	12·2	25·2	24	2·5	6	73·2	25·4	2·50	. . .	. . .	7
11·2	22	41·1	26·3	14·8	24·0	23	5·3	11	77·7	27·3	3·65	. . .	. . .	5
8·0	22	38·2	28·3	9·9	27·0	15	3·0	12	. . .	. . .	1·77	. . .	. . .	14
6·0	22	42·1	26·7	15·4	35·0	23	5·0	2	. . .	. . .	2·67	7·00	. . .	10
2·0	22	40·1	24·7	15·4	32·0	24	3·0	2	. . .	. . .	2·25	12·50	. . .	7
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
11·0	22	43·9	26·7	17·2	39·0	24	4·0	17	77·3	27·2	2·70	·50	. . .	6
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
9·0	20	38·7	25·5	13·2	24·0	24	5·0	2	83·5	28·6	2·52	5·00	. . .	12
4·0	21	42·3	28·1	20·1	41·0	27	3·0	1	84·0	28·2	2·35	4·30	. . .	8
9·0	21	43·0	25·0	18·0	39·0	25	6·5	10	68·7	25·1	3·50	. . .	. . .	5
2·0	22	39·4	24·7	14·7	35·0	23	3·0	13	88·0	29·6	2·45	3·00	. . .	8
10·3	22	41·3	26·1	15·2	40·1	24	3·7	10	79·6	28·3	3·77	·50	. . .	10
0·0	22	39·9	22·9	17·0	33·0	23	8·0	31	. . .	. . .	2·05	5·50	. . .	4
4·0	22	37·3	24·9	12·4	39·0	23	4·0	10	. . .	. . .	2·21	6·35	. . .	10
4·0	22	38·0	25·5	12·5	35·6	15	4·9	1	87·1	26·6	1·61	6·33	. . .	18
11·0	22	42·0	25·0	17·0	32·0	24	5·0	10	71·0	26·5	4·80	. . .	. . .	5
10·0	22	42·0	26·0	16·0	44·0	27	17·0	22	70·0	27·0	3·59	. . .	. . .	5
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
9·0	22	42·5	24·7	17·8	39·0	24	6·0	10	. . .	. . .	3·63	. . .	. . .	7
12·0	22	43·8	30·4	13·4	23·6	16	5·2	10	68·8	26·0	3·15	. . .	. . .	8
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
7·0	21	39·2	25·3	13·9	28·0	24	3·0	21	. . .	. . .	4·62	11·00	. . .	6
9·0	22	39·8	28·8	11·0	30·0	25	3·0	10	76·9	27·9	3·09	·10	. . .	4
− 2·0	22	37·1	21·1	16·0	41·0	15	3·0	3	87·1	23·0	2·21	7·40	. . .	13
− 4·0	22	29·8	19·3	10·5	23·0	16	3·0	3	80·7	21·2	4·77	19·75	. . .	5
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
− 4·0	22	36·1	22·9	13·2	14·7	16	4·2	24	81·1	23·4	5·57	12·90	. . .	10
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
−10·0	22	34·4	23·9	10·5	38·0	15	1·9	17	. . .	. . .	3·00	6·00	. . .	15
− 3·0	22	36·3	20·5	15·8	35·0	23	4·0	9	. . .	. . .	3·40	5·00	. . .	5
− 2·0	22	34·0	22·0	12·0	29·0	23	2·0	10	. . .	. . .	3·63	. . .	. . .	10
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
12·0	22	44·3	27·6	16·7	33·0	25	6·0	31	74·6	26·7	3·62	. . .	. . .	6

TATION.		NUMBER OF DAYS.			WIND.			OBSERVERS.
					PREVAILING DIRECTION.			
Depth of Snow on Ground at End of Month.	Number of Days Rainfall.	Clear.	Fair.	Cloudy.	7 A. M.	2 P. M.	9 P. M.	
. . .	14	4	5	22	NW	NW	NW	Oscar D. Stewart, Sgt. Sig. Corps.
. . .	. . .	. . .	. . .	. . .	. .	. .	. .	Smith Curtis.
. . .	7	8	13	13	W	W	W	Rev. A. Thos. G. Apple.
. . .	6	11	10	10	NW	NW	NW	C. M. Dechant, C.E.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	Prof. J. H. Rohrbach.
. . .	5	. . .	. . .	. . .	. . .	. . .	. . .	Dr. Charles B. Dudley.
. . .	7	5	13	13	W	W	W	Prof. J. A. Stewart.
. . .	9	7	4	20	NW	NW	NW	Charles Beecher.
. . .	6	12	8	11	NW	NW	NW	J. L. Heacock.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	J. E. Forsythe.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	E. C. Lorentz.
30	12	7	8	16	W	W	W	T. B. Lloyd
. . .	10	6	4	21	W	W	W	Prof. Wm. Frear.
. . .	14	8	7	16	SW	SW	SW	Geo. H. Dunkle.
. . .	9	14	10	7	NW	NW	NW	Jesse C. Green, D.D.S.
. . .	8	15	8	8	S	W	W	W. T. Gordon.
. . .	7	14	9	8	NW	NW	NW	
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	Rev. W. W. Deatrick, A.M.
. . .	. . .	4	10	17	SW	SW	SW	C. M. Thomas, B.S.
. . .	16	7	5	19	W	W	W	Nathan Moore.
. . .	8	7	5	19	W	W	W	Prof. John A. Robb.
. . .	9	. . .	. . .	. . .	. . .	. . .	. . .	Robert M. Graham.
. . .	14	6	5	20	W	SW	S	R. B. Derickson.
. . .	7	9	9	13	W	W	W	J. E. Pague.
. . .	7	8	8	15	. . .	. .	. . .	Frank Ridgway, Sgt. Sig. Corps.
. . .	5	8	8	15	NW	NW	NW	Prof. Susan J. Cunningham.
. . .	14	2	7	22	S	S	S	Peter Wood, Sgt. Sig. Corps.
. . .	10	9	15	7	NW	NW	NW	Wm. Hunt.
. . .	7	. . .	. . .	. . .	NW	NW	NW	Robert L. Haslet.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	P. C. Richardson.
. . .	6	11	8	12	W	NW	NW	Thomas F. Sloan.
. . .	. . .	. . .	. . .	. . .	. . .	. .	. . .	Prof. W. J. Swigart.
. . .	12	2	11	18	W	W	W	Prof. Albert E Maltby.
. . .	5	3	23	5	E	E	NE	J. F. Baumeister.
. . .	5	9	10	12	W	W	W	A. M. Schmidt, A.B.
. . .	8	3	10	18	NW	NW	NW	Wm. T. Butz.
. . .	10	11	7	13	SW	SW	SW	George W. Hayes, C.E., Ph G.
. . .	4	. . .	. . .	. . .	. . .	. . .	. . .	H. D. Miller, M.D.
. . .	10	4	8	19	SW	SW	SW	Armstrong & Brownell.
. . .	18	4	5	22	NW	SW	S	Prof. S. H. Miller.
. . .	5	17	7	7	NW	SW	NW	Charles Moore, D.D.S.
. . .	5	18	9	11	W	W	W	Lerch & Rice.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	G. R. Hanley.
. . .	7	13	7	11	W	W	W	Frank Mortimer.
. . .	8	14	7	10	NW	W	W	Luther M. Dey, Sgt. Sig. Corps.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	C. L. Peck.
. . .	6	6	10	15	NW	NW	NW	E. C. Wagner.
. . .	4	10	7	14	SW	NW	NW	J. M. Boyer,
. . .	13	9	1	21	NW	NW	NW	W. M. Schrock.
. . .	5	5	9	17	SW	SW	SW	E. S. Chase.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	A. H. Berlin.
. . .	10	3	6	22	N	NW	N	H. D. Deming.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	Prof. N. P. Kinsley.
. . .	15	6	2	23	SW	SW	SW	Wm. Loveland.
. . .	5	6	6	19	NW	NW	NW	Theodore Day.
. . .	10	. . .	. . .	. . .	. . .	. . .	. . .	John Torrey.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	H. S. Brunot.
. . .	6	19	5	7	NW	NW	NW	Mrs. L. H. Grenewald.

T. F. TOWNSEND, *Sergeant Signal Corps, Assistant.*

	Erie.
1	.03
2	. .
3	. .
4	.06
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6	.03
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21	.05
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24	. .
25	.02
26	. .
27	.06
28	.10
29	. .
30	. .
31	.08
	1.77

PRECIPITATION FOR DECEMBER, 1888.

	Erie.	Greenville.	New Castle.	Meadville.	Columbus.	Pittsburgh.	Uniontown.	Tionesta.	Indiana.	Somerset.	Grampian Hills.	Emporium.	Phillipsburg.	Hollidaysburg.	Smethport.	Altoona.	Charlesville.	State College.	McConnellsburg.	Lock Haven.	New Bloomfield.	Carlisle.	Wellsboro.	York.	Harrisburg.	Selins Grove.	Wysox.	Eagles Mere.	Catawissa.	Girardville.	Lebanon	Lancaster.	Drifton.	Reading.	Scranton.	Pottstown.	West Chester.
1	.03	. .	. .	.20	.14	.02	.26	.10	. .	.13	.03		.03	. .	.01	. .	. .	.03	. .	. .	. .	. .	. .	. .	. .	. .	. .	.14	.01	. .	. .	. .	. .	. .	. .	. .	. .
2	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
3	. .	.01	. .	.19	. .	. .	. .	. .	. .	. .	. .	. .	.01	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
4	.06	.03	.15	. .	.14	.01	. .	.30	.30	.05	.17	.04	.03	. .	.08	. .	.02	.03	. .	. .	. .	. .	.17	. .	. .	. .	.02	.20	.02	. .	.01	. .	.10	. .	. .	. .	.0
5	.14	.20	. .	.18	.18	.12	.14	.	.12	.03	. .	. .	. .	.11	.10	. .	.12	.06	.14	.01	. .	. .	.20	. .	. .	.10	.21	.16	.21	. .	.02	.03	. .	. .	. .	. .	. .
6	.03	.01	. .	.	.05	. .	. .	. .	. .	.04	.17	.20	. .	. .	. .	.09	.01	. .	. .	.70	.02	.02	. .	. .	.08	. .	.01	.05	. .	. .	.11	. .	.	.10	. .	.10	.1
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8	.36	.27	.45	.25	.59	.06	. .	. .	.04	.	. .	.06	. .	. .	.40	. .	. .	. .	. .	. .	. .	. .	.35	. .	. .	. .	.10	.44	. .	. .	. .	. .	. .	. .	. .	. .
9	.23	.19	. .	.80	. .	.32	.46	.15	.46	.30	.42	.40	.45	.21	. .	.17	.03	.23	.08	.33	.45	.13	.03	.05	.21	.30	.05	. .	.30	.34	.29	.26	.21	.35	.22	.40	.1
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13	. .	.02	. .	.12	.09	.02	. .	. .	. .	. .	.03	. .	.01	. .	. .	. .	. .	. .	. .	. .	. .	.01	.10	. .	. .	. .	. .	.22	. .	. .	. .	. .	. .	. .	. .	. .	. .
14	. .	.08	. .	.05	. .	. .	.06	.30	.08	.20	. .	.14	.01	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
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16	.27	.24	. .	.21	.70	.58	.13	.	.10	.15	. .	.46	. .	. .	.40	. .	.19	. .	.30	.45	.15	. .	1.36	.03	.04	. .	.08	1.32	.50	.32	.15	. .	. .	.10	. .	. .	. .
17	.11	.04	.49	.50	.27	.08	.42	1.00	.05	.42	.80	.29	.36	.80	.36	.22	1.12	.50	1.50	1.21	1.30	.9	. .	2.32	1.19	. .	1.28	. .	2.21	2.30	2.05	2.37	1.62	1.92	1.42	3.60	3.7
18	.23	.08	. .	.70	.05	.07	. .	. .	.05	.04	.47	.32	.85	.14	. .	.57	.11	1.08	.24	. .	1.10	1.35	2.10	.73	.60	2.04	. .	.18	.01	.45	.55	.51	.	.72	. .	. .	.0
19	. .	.03	. .	.65	.01	.02	.30	.20	. .	.08	.03	. .	.05	. .	. .	. .	. .	.03	. .	. .	. .	. .	. .	.05	. .	.	. .	. .	. .	. .	.01	. .	.12	. .	. .	. .	.0
20	. .	.01	. .	.50	. .	. .	.08	. .	. .	. .	. .	. .	.01	. .	.03	. .	. .	.02	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
21	.05	.04	1.03	.15	.02	.02	.16	. .	.40	.08	. .	.06	.01	. .	. .	. .	. .	. .	. .	. .	. .	. .	.10	. .	. .	. .	. .	.24	. .	. .	. .	. .	. .	. .	. .	. .	. .
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25	.02	. .	. .	. .	.01	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
26	. .	.04	.23	. .	.08	.04	. .	. .	1.00	. .	.14	. .	. .	.11	. .	. .	. .	. .	. .	. .	. .	. .	1.04	. .	. .	. .	.20	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
27	.06	.10	. .	. .	.37	.22	.66	. .	.01	.60	.48	.82	.40	.26	.56	.39	. .	.06	.44	.55	.60	.34	.12	.41	.36	1.01	.16	1.42	.70	1.06	.56	.33	. .	.33	.55	.70	.6
28	.10	.02	. .	.80	. .	. .	. .	.20	. .	. .	. .	.08	.01	. .	.16	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.06	. .	. .
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31	.08	.20	. .	. .	.30	.08	. .	. .	. .	.09	.15	.07	.05	.03	.11	. .	.03	.03	. .	.04	.01	.02	. .	.03	.02	. .	. .	.40	.01	. .	.02	. .	. .	.02	. .	. .	.1
	1.77	1.61	2.45	5.30	3.00	1.66	2.67	2.25	2.52	2.21	2.89	2.94	2.28	1.68	2.21	1.44	1.63	2.07	2.70	3.31	3.63	2.77	5.57	3.62	2.50	3.45	2.51	4.77	3.97	4.62	3.77	3.50	2.05	3.44	2.35	4.80	4.9

RECIPITATION FOR DECEMBER, 1888.

Carlisle.	Wellsboro.	York.	Harrisburg.	Selins Grove.	Wysox.	Eagles Mere.	Catawissa.	Girardville.	Lebanon.	Lancaster.	Drifton.	Reading.	Scranton.	Pottstown.	West Chester.	Coatesville.	Dyberry.	Honesdale.	Bethlehem.	Quakertown.	Swarthmore.	Philadelphia.	Coudersport.	Selsholtzville.
.	. .	.	. .	. .	. .	.14	.01	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.06	. .	. .	. .		. .	. .
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.	.17	.	. .	. .	.08	.20	.02	. .	.01	. .	.10	. .	. .	. .	.08	.01	. .	.04	. .	. .	. .	. .	. .	. .
.	.20	.	. .	.10	.21	.16	.21	. .	.02	.03	. .	. .	. .	. .	. .	. .	. .	.02	.04	. .	. .	. .	. .	. .
.02	. .	.	.08	. .	.01	.05	. .	. .	.11	. .	. .	.10	. .	.10	.14	.10	. .	.12	. .	.17	. .	.03	.10	.11
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.	.35	.	. .	. .	.10	.44	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
.13	.03	.05	.21	.30	.05	. .	.30	.34	.29	.26	.21	.35	.22	.40	.17	.12	.78	.51	.41	.42	.15	.15	.90	.38
.	. .	.	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.02	. .	. .	. .	. .	. .	.15	.10	. .	. .
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.01	.10	.	. .	. .	. .	.22	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
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.	1.36	.03	.04	. .	.08	1.32	.50	.32	.15	. .	. .	. .	.10	. .	. .	. .	. .	2.23	2.61	3.38	2.96	2.23	.70	3.22
9	. .	2.32	1.19	. .	1.28	. .	2.21	2.30	2.05	2.37	1.62	1.92	1.42	3.60	3.76	3.89	1.82	. .	. .	. .	. .	. .	. .	. .
.35	2.10	.73	.60	2.04	. .	.13	.01	.45	.55	.51	.	.72	. .	. .	.06	.24	.30	. .	. .	.10	. .	.05	.20	. .
.	. .	.05	. .	. .	. .	. .	. .	. .	.01	. .	.19	. .	. .	. .	.02	.01	. .	. .	. .	. .	. .	. .	.10	. .
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.	.10	. .	. .	. .	. .	.24	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.01	. .	. .	. .	. .	.10	. .
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.34	.12	.41	.36	1.01	.16	1.42	.70	1.06	.56	.33	. .	.33	.55	.70	.65	.75	.50	.67	.52	.64	.36	.54	1.40	.67
.	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.06	. .	. .	. .	. .	.01	. .	. .	. .	. .	. .	. .
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.02	. .	.03	.02	. .	. .	.40	.01	. .	.02	. .	. .	.02	. .	. .	.13	.13	. .	.01	.01	.04	.03	.05	. .	. .
.77	5.57	3.62	2.50	3.45	2.51	4.77	3.97	4.62	3.77	3.50	2.05	3.44	2.35	4.80	4.97	5.25	3.40	3.63	3.59	4.75	3.65	3.15	3.50	4.38

Philadelphia.	Coudersport.	Scisholtzville.	Frederick.	Ottsville.	Smith's Corner.	Doylestown.	Lansdale.	Forks of Neeham'y.	Germantown.	Point Pleasant.
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·03	·10	·11	·15	·17	·18	. .	. .	·25	·16	·12
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·15	·90	·38	·28	·53	·29	·36	·36	·17	·14	·46
·10	. .	. .	. .	. .	. .	. .	. .	·10	·18	. .
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2·23	·70	3·22	3·34	3·30	2·89	2·70	2·75	2 72	2·76	3·00
·05	·20	. .	. .	. .	. .	. .	. .	. .	. .	. .
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·54	1·40	·67	·55	·66	·60	·55	·60	·55	·51	·58
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·05	. .	. .	04	·07	·04	·04	·05	·05	·06	·04
3·15	3·50	4·38	4·36	4·43	4·00	3·65	3·76	3·74	3·81	4·20

T. F. T.

Auroras.—Eagles Mere, 23d.

Parhelia—Eagles Mere, 15th; Dyberry, 4th.

WEATHER SIGNALS.

Displayman.	*Station.*
U. S. Signal Office,	Philadelphia.
Wanamaker & Brown,	"
Pennsylvania Railroad Company,	"
Continental Brewing Company,	"
Samuel Simpson,	"
B. T. Babbitt,	"
Western Meat Company,	"
Neptune Laundry,	"
Chester Oil Company,	Chester.
C. W. Burkhart,	Shoemakerville.
A. N. Lindenmuth,	Allentown.
C. B. Whitehead,	Bradford.
Capt. Geo. R. Guss,	West Chester.
Werner & Son,	Emporium.
C. E. Lenhart,	Latrobe.
Thomas F. Sloan,	McConnellsburg.
J. H. Fulmer,	Muncy.
W. T. Butz,	New Castle.
S. W. Morrison,	Oxford.
Capt. A. Goldsmith,	Quakertown.
J. L. Morrison,	Sharon.
Wm. A. Engel,	Shenandoah.
Wm. Schrock,	Somerset.
Postmaster,	Meadville.
Frank Ross,	Oil City.
Lerch & Rice,	Bethlehem.
John W. Aitken,	Carbondale.
Signal Office,	Erie.
J. R. Raynsford,	Montrose.
E. P. Wilbur & Co.,	South Bethlehem.
Agricultural Experiment Station,	State College.
Signal Office,	Pittsburgh.
E. H. Baker,	Williamsport.
New Era,	Lancaster.
State Normal School,	Clarion.
Clarion Collegiate Institute,	Rimersburg.
E. S. Chase,	Eagles Mere.
Thiel College,	Greenville.
D. G. Hurley,	Altoona.
Armstrong & Brownell,	Smethport.
J. E. Forsythe,	Butler.

Displayman.	*Station.*
James H. Fones,	Tionesta.
Wister, Hacker & Savage,	Germantown.
W. J. Thompson & Co.,	Clifton Heights.
Steward M. Dreher,	Stroudsburg.
State Normal School,	Millersville.
E. C. Wagner,	Girardville.
Hartford P. Brown,	Rochester.
L. H. Grenewald,	York.
J. E. Pague,	Carlisle.
C. L. Peck,	Coudersport.
H. D. Miller,	Drifton.
Smith Curtis,	Beaver.
M. Tannehill,	Confluence.
S. C. Burkholder,	Pollock.
Robt. M. Graham,	Catawissa.
Henry F. Bitner,	Millersville.
A. J. Edelman,	Pottstown.
A. M. Wildman,	Langhorn.
N. E. Graham,	East Brady.
B. F. Gilmore,	Chambersburg.
Frank M. Morrow,	Altoona.
A. Simon's Sons,	Lock Haven.
E. W. McArthurs,	Meadville.
J. K. M. McGovern,	Lock No. 4.
Raftsman's Journal,	Clearfield.

PENNSYLVANIA STATE WEATHER SERVICE.

MONTHLY WEATHER REVIEW

FOR JANUARY, 1889.

Prepared under the Direction of the Committee on Meteorology of the FRANKLIN INSTITUTE.

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, January 31, 1889.

TEMPERATURE.

The mean temperature for January, 1889, 31°·9, is about 5° above the average, and 9°·8 above that of January, 1888. The mean of the daily maximum temperature was 31°·6, and of the daily minimum temperature, 27°·2. The warmest period of the month was the 17th, and the coldest from the 19th to the 23d inclusive.

The highest temperatures reported were Westtown, 68°·0; Carlisle, 65°·0; Reading, 64°·5; McConnellsburg, 64°·0; Lancaster, 64°·0, and New Bloomfield, 64°·0. The lowest were Charlesville, minus 5°; Emporium, minus 3°; Honesdale, minus 3°; Smethport, minus 2°·5; Hollidaysburg, minus 2°; New Castle, minus 2°; Coudersport, minus 2°, and Wellsboro, minus 2°. Stations with the highest mean for the month were Philadelphia, 37°·3; Uniontown, 36°·5; Pittsburgh, 35°·2; Catawissa, 35°; Pottstown, 35°, and Indiana, 34°·9.

Those with the lowest were Eagles Mere, 26°·6; Honesdale, 27°·8; Phillipsburg, 28°·3; Greenville, 28°·7; Coudersport, 28°·6, and Clarion, 29°·1.

BAROMETER.

The mean pressure, 30·05, is ·05 below the normal. The highest readings noted were on the 17th, 19th and 23d, and the lowest on the 9th and 27th. That of the 9th accompanied the tornadoes which passed over the state on that date.

PRECIPITATION.

The average rainfall, including melted snow, was 3·54 inches, which is slightly above the normal. The fall was very evenly distributed, both during the month and over the state. Light snow squalls were frequent. The heaviest snowfall occurred on the 20th. The greatest totals in inches for the entire month were, Meadville, 21; Eagles Mere, 19; Coudersport, 18; Somerset, 13; Wellsboro, 12, and Rimersburg, 12. Very little snow remained on the ground at the end of the month.

WIND AND WEATHER.

The prevailing wind was from the west. On the 9th, several portions of the state were visited by tornadoes, which did a large amount of damage. Owing to the extreme mildness of the month much plowing was done and no ice was harvested. Winter grain is reported in good condition.

Average number.—Rainy days, 10; clear days, 9; cloudy days, 9.

MISCELLANEOUS PHENOMENA.

Snow.—Charlesville, 12th, 14th, 20th, 21st, 28th, 29th, 30th; Reading, 20th, 28th, 31st; Hollidaysburg, 7th, 11th, 14th, 20th, 21st, 27th, 28th, 31st; Wysox, 20th, 27th, 28th; Quakertown, 20th, 31st; Emporium, 20th, 24th; State College, 15th, 20th, 31st; Phillipsburg 6th, 7th, 9th, 11th, 20th, 21st, 28th, 29th, 30th, 31st; Coatesville, 20th; Clarion, 7th, 11th, 20th, 21st, 28th, 30th, 31st; Grampian Hills, 6th, 7th, 11th, 21st, 30th, 31st; Lock Haven, 21st, 23d; Catawissa, 20th, 28th, 31st; Meadville, 7th, 11th, 18th, 20th, 21st, 28th, 29th, 30th, 31st; Carlisle, 20th, 28th; Harrisburg, 20th, 21st; Swarthmore, 20th; Tionesta, 20th, 21st, 28th, 29th; McConnellsburg, 20th; Huntingdon, 20th, 21st; Indiana, 7th, 11th, 20th, 21st, 28th, 29th, 30th, 31st; Lancaster, 20th, 31st; New Castle, 19th, 20th, 21st, 28th, 30th; Lebanon, 20th, 27th, 28th, 31st; Greenville, 6th, 7th, 9th, 11th, 18th, 20th, 21st, 22d, 27th, 28th, 29th, 30th, 31st; New Bloomfield, 20th, 21st, 28th, 31st; Philadelphia, 20th, 28th; Coudersport, 6th, 21st, 22d, 24th, 27th, 28th, 29th, 30th, 31st; Girardville, 20th, 31st; Selins Grove, 20th; Eagles Mere, 9th, 10th, 11th, 20th, 21st, 27th, 28th, 31st; Wellsboro, 7th, 21st, 27th, 28th, 30th, 31st; Westtown, 20th.

Coronæ.—Charlesville, 8th, 11th, 13th; Reading, 9th; Hollidaysburg, 4th, 8th, 12th; Clarion, 25th; Lebanon, 9th, 10th, 11th, 12th, 14th, 19th, 23d, 24th; Greenville, 17th; Eagles Mere, 13th.

Solar Halos.—Charlesville, 4th, 19th, 23d; Lebanon, 8th; Philadelphia, 4th; Eagles Mere, 8th, 13th, 15th, 19th, 22d, 31st; Wellsboro, 15th, 22d.

Lunar Halos.—Charlesville, 19th; Reading, 19th; Hollidaysburg, 19th; Clarion, 14th, 19th; Carlisle, 20th; Lancaster, 19th; New Castle, 12th, 19th;

Monthly Summary of Reports by Voluntary Observers of the Pennsylvania State Weather Se

County.	Station.	Elevation above Sea Level (feet).	Barometer.			Temperature.													Relative Humidity.	Dew Point.	Precip	
							Maximum.		Minimum.				Daily Range.									
			Mean.	Highest.	Lowest.	Mean.	Highest.	Date.	Lowest.	Date.	Mean of Maximum.	Mean of Minimum.	Mean.	Greatest.	Date.	Least.	Date.			Total Inches.	Total Snowfall During Month.
Allegheny,[1]	Pittsburgh,	847	30·020	30·470	29·010	35·2	61·0	16	17·0	22	42·7	30·3	12·4	29·0	23	4·0	7	74·6	24·7	2·90	5·40
Beaver,	Rochester	821	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Bedford,	Charlesville,	1,300	. . .	. . .	. . .	31·3	59·5	17	— 5·0	23	40·4	25·0	15·4	43·0	23	2·0	20	75·1	23·8	3·81	9·50
Berks,[1]	Reading,	304	30·063	30·595	29·251	32·1	64·5	17	7·0	23	41·4	25·0	16·4	26·0	23	6·0	27	. . .	. . .	3·74	4·50
Berks,	Kutztown— Keystone State Normal School,	540	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Blair,[2]	Altoona,	1,181	. . .	. . .	. . .	37·0	59·0	18	14·0	23	44·8	29·3	15·5	25·0	19	8·0	6	74·3	29·0	1·82	. . .
Blair,	Hollidaysburg,	947	. . .	. . .	. . .	32·0	61·0	17	— 2·0	23	41·0	24·0	17·0	42·0	23	8·0	27	84·0	28·0	2·56	6·10
Bradford,	Wysox,	718	. . .	. . .	. . .	30·0	59·0	17	0·0	30	36·9	21·4	15·5	32·0	23	3·5	4	83·0	25·0	2·70	8·00
Bucks,	Quakertown,	536	30·040	30·580	29·230	32·4	59·0	17	7·0	23	41·9	24·0	17·9	35·0	23	5·0	27	83·0	27·1	4·58	5·25
Butler,	Butler,	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Cambria,	Johnstown,	1,184	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Cameron,	Emporium,	1,030	. . .	. . .	. . .	30·5	56·0	17	— 3·0	23	38·2	22·4	15·8	39·0	23	4·0	14	78·0	23·0	2·75	7·50
Centre,	State College— Agricultural Experiment Station,	1,191	30·091	30·676	29·152	30·1	57·0	17	10·0	23	37·8	21·7	15·5	24·0	24	5·0	1	90·2	27·9	1·97	6·61
Centre,	Phillipsburg,	1,350	. . .	. . .	. . .	28·3	56·0	17	— 1·0	23	35·4	17·2	18·2	47·0	23	4·0	7	. . .	. . .	2·41	6·25
Chester,	West Chester,	455	30·018	30·573	29·178	34·5	58·0	9	16·0	20	42·1	28·3	13·8	25·0	0	4·0	6	73·0	27·1	4·78	2·50
Chester,	Coatesville,	380	. . .	. . .	. . .	33·2	61·5	17	13·5	23	44·0	25·2	18·8	32·0	9	5·0	6	. . .	. . .	4·13	3·30
Chester,	Westtown,	550	30·130	30·670	29·370	33·0	68·0	17	20·0	20	42·3	29·4	12·9	21·0	17	4·0	5	. . .	. . .	3·51	4·00
Clarion,	Rimersburg,	1,500	. . .	. . .	. . .	30·0	50·0	17	12·0	28	35·0	24·0	11·0	22·0	13	1·0	7	. . .	. . .	. . .	12·75
Clarion,	Clarion— State Normal School,	1,530	. . .	. . .	. . .	29·1	56·5	17	6·5	23	37·6	21·6	16·0	28·5	23	5·5	7	85·0	24·2	3·35	. . .
Clearfield,	Grampian Hills,	1,450	. . .	. . .	. . .	28·8	52·0	17	6·0	23	34·4	23·8	10·6	30·0	23	2·0	7	. . .	. . .	3·32	17·00
Clinton,	Lock Haven,	560	. . .	. . .	. . .	32·0	57·0	17	0·5	23	37·5	22·4	15·1	29·5	23	4·0	7	. . .	. . .	3·48	9·00
Columbia,	Catawissa,	491	. . .	. . .	. . .	35·0	62·0	17	11·0	23	41·3	28·0	13·3	29·0	23	3·0	26	. . .	. . .	3·22	6·25
Crawford,	Meadville— Allegheny College,	1,050	30·137	30·615	29·280	30·1	56·5	15	12·0	19	40·9	27·6	13·3	20·0	4	3·0	8	70·1	27·4	4·25	21·00
Cumberland,	Carlisle,	480	. . .	. . .	. . .	33·2	65·0	17	4·0	23	41·0	27·5	13·5	31·0	23	0·5	5	75·0	27·8	3·49	4·00
Dauphin,[1]	Harrisburg,	361	30·086	30·620	29·210	32·6	62·0	17	13·0	23	39·3	25·5	13·8	28·0	17	6·0	27	. . .	. . .	2·66	4·50
Delaware,	Swarthmore— Swarthmore College,	190	30·041	30·442	29·392	35·7	56·5	18	17·9	20	41·8	28·8	13·0	23·7	23	3·8	6	80·0	29·0	4·80	2·00
Erie,[1]	Erie,	681	30·080	30·550	29·220	31·0	53·0	16	12·0	20	38·0	27·0	11·0	23·0	16	2·0	28	. . .	. . .	2·71	. . .
Fayette,	Uniontown,	1,000	30·000	30·366	29·157	36·5	62·0	16	13·0	22	46·3	27·5	18·8	40·0	23	6·0	21	79·0	30·0	2·34	. . .
Forest,	Tionesta,	1,058	. . .	. . .	. . .	29·5	54·0	17	4·0	23	38·1	24·0	14·1	39·0	23	3·0	8	85·0	25·2	3·50	10·00
Franklin,[1]	Chambersburg— Wilson Female College,	618	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Fulton,	McConnellsburg,	875	. . .	. . .	. . .	33·6	64·0	17	2·0	23	43·5	26·4	17·1	40·0	23	7·0	27	76·0	26·5	3·53	7·50
Huntingdon,	Huntingdon— The Normal College,	650	. . .	. . .	. . .	32·3	61·0	17	— 1·5	23	38·7	23·0	15·7	39·5	23	2·5	7	. . .	. . .	2·84	5·00
Indiana,	Indiana— State Normal School,	1,350	. . .	. . .	. . .	34·9	59·0	16	8·0	30	41·8	27·5	14·3	30·0	10	4·0	20	89·0	32·1	2·94	8·10
Lackawanna,	Scranton,	750	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Lancaster,	Lancaster— Franklin and Marshall College,	413	30·065	31·068	29·225	34·9	64·0	17	14·5	23	41·9	26·1	15·8	27·5	23	5·5	6	74·8	26·7	2·83	2·50
Lawrence,	New Castle,	932	. . .	. . .	. . .	31·2	56·0	17	— 2·0	22	39·3	23·2	16·1	38·0	23	5·0	7	89·4	29·8	3·17	10·50
Lebanon,	Lebanon,	480	30·041	30·595	29·205	33·0	62·0	17	11·5	23	. . .	26·2	. . .	. . .	. . .	. . .	. . .	79·8	28·3	4·26	5·20
Luzerne,	Drifton— Drifton Hospital,	1,655	. . .	. . .	. . .	30·4	60·0	17	7·0	19	41·7	23·0	18·7	36·0	26	7·0	7	. . .	. . .	3·74	3·25
McKean,	Smethport,	1,500	. . .	. . .	. . .	30·0	52·0	17	— 1·5	23	35·2	24·1	11·1	48·5	23	3·0	8	80·0	24·0	. . .	. . .
Mercer,[1]	Greenville— Thiel College,	1,000	30·063	30·492	29·982	28·7	54·6	17	9·0	22	38·2	24·0	14·2	36·1	23	4·0	7	89·3	25·8	3·52	7·87
Montgomery,	Pottstown,	150	. . .	. . .	. . .	35·0	58·0	17	10·0	23	40·3	29·4	10·9	21·0	4	2·0	5	72·0	27·0	4·12	5·00
Northampton,	Bethlehem,	360	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Northumberland,	Shamokin,	733	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Perry,	New Bloomfield,	400	. . .	. . .	. . .	31·7	64·0	17	0·0	23	42·4	21·0	19·5	38·0	23	6·0	27	. . .	. . .	3·62	8·50
Philadelphia,[1]	Philadelphia,	117	30·070	30·630	29·190	37·3	59·0	17	18·0	20	45·0	32·0	13·0	24·0	9	5·0	6	72·0	28·6	3·75	1·75
Potter,	Coudersport,	1,670	. . .	. . .	. . .	28·6	50·0	4	— 2·0	23	36·4	20·5	15·9	43·0	24	10·0	2	76·2	22·3	4·80	17·50
Schuylkill,	Girardville,	1,000	30·070	30·573	29·444	32·7	51·0	9	10·0	21	40·0	24·0	16·0	33·0	25	5·0	8	. . .	. . .	3·80	9·00
Snyder,	Selins Grove,	448	. . .	. . .	. . .	33·3	55·0	17	8·0	23	39·1	29·1	10·0	27·0	23	1·0	7	79·1	27·1	4·00	7·50
Somerset,	Somerset,	2,250	. . .	. . .	. . .	30·7	54·0	4	7·5	23	39·5	23·4	16·1	29·0	31	4·0	7	86·0	27·2	3·48	12·75
Sullivan,	Eagles Mere,	2,000	30·112	30·615	29·277	26·6	50·0	17	— 1·0	20	32·2	21·2	11·1	26·0	20	2·0	6	71·1	19·0	4·92	19·25
Susquehanna,	Montrose,	1,636	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Tioga,	Wellsboro,	1,327	30·015	30·605	29·186	29·7	58·0	17	— 2·0	23	37·8	23·9	13·9	30·4	19	4·6	16	80·9	24·5	7·08	12·40
Venango,	Franklin,	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Warren,	Columbus,	1,410	30·016	30·735	29·354	29·2	50·0	17	4·0	23	35·9	22·5	13·4	42·0	23	2·0	7	. . .	. . .	3·22	6·00
Wayne,	Dyberry,	1,100	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Wayne,	Honesdale,	1,000	. . .	. . .	. . .	27·8	54·0	17	— 3·0	23	33·1	20·6	14·5	36·0	23	4·0	7	. . .	. . .	4·15	. . .
Westmoreland,	Greensburg,	1,075	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
York,[1]	York,	385	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .

[1] Observations taken at 8 A. M. and 8 P. M. [2] Observations taken at 12 Noon.

BY VOLUNTARY OBSERVERS OF THE PENNSYLVANIA STATE WEATHER SERVICE FOR JANUA

Temperature.										Precipitation.				Num
nimum.			Daily Range.					Relative Humidity.	Dew Point.					
Date.	Mean of Maximum.	Mean of Minimum.	Mean.	Greatest.	Date.	Least.	Date.			Total Inches.	Total Snowfall During Month.	Depth of Snow on Ground at End of Month.	Number of Days Rainfall.	Clear.
22	42·7	30·3	12·4	29·0	23	4·0	7	74·6	24·7	2·50	5·40	1·00	14	4
. . .	. . .	. . .	. . .	. . .	. .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
23	40·4	25·0	15·4	43·0	23	2·0	20	75·1	23·8	3·81	9·50	0·50	9	9
23	41·4	25·0	16·4	26·0	23	6·0	27	. . .	. . .	3·74	4·50	. . .	9	12
. . .	. .	. .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. .	. . .	. . .
23	44·8	29·3	15·5	25·0	19	8·0	6	74·3	29·0	1·82	. . .	. . .	7	. . .
23	41·0	24·0	17·0	42·0	23	8·0	27	84·0	28·0	2·56	6·10	3·00	6	9
30	36·9	21·4	15·5	32·0	23	3·5	4	83·0	25·0	2·70	8·00	3·00	10	8
23	41·9	24·0	17·9	35·0	23	5·0	27	83·0	27·1	4·58	5·25	. . .	11	10
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
23	38·2	22·4	15·8	39·0	23	4·0	14	78·0	23·0	2·75	7·50	. . .	10	5
23	37·8	21·7	15·5	24·0	24	5·0	1	90·2	27·9	1·97	6·61	1·50	7	9
23	35·4	17·2	18·2	47·0	23	4·0	7	. . .	. . .	2·41	6·25	2·00	12	4
20	42·1	28·3	13·8	25·0	9	4·0	6	73·0	27·1	4·78	2·50	. . .	13	16
23	44·0	25·2	18·8	32·0	9	5·0	6	. . .	. . .	4·13	3·30	. . .	13	15
20	42·3	29·4	12·9	21·0	17	4·0	5	. . .	. . .	3·51	4·00	. . .	8	9
28	35·0	24·0	11·0	22·0	13	1·0	7	. . .	. . .	. . .	12·25	4·00	. . .	3
23	37·6	21·6	16·0	28·5	23	5·5	7	85·0	24·2	3·35	. . .	. . .	5	5
23	34·4	23·8	10·6	30·0	23	2·0	7	. . .	. . .	3·32	17·00	6·50	14	4
23	37·5	22·4	15·1	29·5	23	4·0	7	. . .	. . .	3·48	9·00	2·00	6	11
23	41·3	28·0	13·3	29·0	23	3·0	28	. . .	. . .	3·22	6·25	2·00	10	10
19	40·9	27·6	13·3	20·0	4	3·0	8	70·1	27·4	4·25	21·00	6·00	13	11
23	41·0	27·5	13·5	31·0	23	0·5	5	75·0	27·8	3·49	4·00	. .	12	9
23	39·3	25·5	13·8	28·0	17	6·0	27	. . .	. . .	2·66	4·50	. . .	11	7
20	41·8	28·8	13·0	23·7	23	3·8	6	80·0	29·0	4·80	2·00	. . .	6	8
20	38·0	27·0	11·0	23·0	16	2·0	28	. . .	. . .	2·71	. . .	. . .	19	2
22	46·3	27·5	18·8	40·0	23	6·0	21	79·0	30·0	2·34	. .	. .	11	7
23	38·1	24·0	14·1	39·0	23	3·0	8	85·0	25·2	3·50	10·00	4·00	14	5
. . .	. . .	. . .	. . .	. . .	. .	. . .	. .	. . .	. . .	. . .	. .	. . .	. . .	. . .
23	43·5	26·4	17·1	40·0	23	7·0	27	76·0	26·5	3·53	7·50	. . .	7	13
23	38·7	23·0	15·7	39·5	23	2·5	7	. . .	. . .	2·84	5·00	. . .	7	8
30	41·8	27·5	14·3	30·0	10	4·0	20	89·0	32·1	2·94	8·10	4·00	14	3
. . .	. .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. .	. . .	. . .	. .
23	41·9	26·1	15·8	27·5	23	5·5	6	74·8	26·7	2·83	2·50	0·50	11	10
22	39·3	23·2	16·1	38·0	23	5·0	7	89·4	29·8	3·17	10·50	1·00	7	3
23	. . .	26·2	. . .	. . .	. . .	. . .	. . .	79·8	28·3	4·26	5·20	1·00	11	11
19	41·7	23·0	18·7	36·0	26	7·0	7	. . .	. . .	3·74	3·25	. . .	8	. . .
23	35·2	24·1	11·1	48·5	23	3·0	8	80·0	24·0	. . .	. . .	. . .	. . .	. . .
22	38·2	24·0	14·2	36·1	23	4·0	7	89·3	25·8	3·52	7·87	1·50	14	2
23	40·3	29·4	10·9	21·0	4	2·0	5	72·0	27·0	4·12	5·00	. . .	9	16
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
23	42·4	27·9	19·5	38·0	23	6·0	27	. . .	. . .	3·52	8·50	1·00	6	15
20	45·0	32·0	13·0	24·0	9	5·0	6	72·0	28·6	3·75	1·75	. .	11	14
23	36·4	20·5	15·9	43·0	24	10·0	2	78·2	22·3	4·80	17·50	6·00	11	11
21	40·0	24·0	16·0	33·0	25	5·0	8	. .	. . .	3·80	9·00	3·00	9	14
23	39·1	29·1	10·0	27·0	23	1·0	7	79·1	27·1	4·00	7·50	. .	8	5
23	39·5	23·4	16·1	29·0	31	4·0	7	86·0	27·2	3·48	12·75	4·00	4	. . .
20	32·2	21·2	11·1	26·0	20	2·0	6	71·1	19·0	4·92	19·25	8·50	10	8
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
23	37·8	23·9	13·9	20·4	19	4·6	16	80·9	24·5	7·02	12·40	4·30	14	4
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
23	35·9	22·5	13·4	42·0	23	2·0	7	. . .	. . .	3·22	6·00	2·00	. . .	. . .
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
23	35·1	20·6	14·5	36·0	23	4·0	7	. . .	. . .	4·15	. . .	5·30	11	. . .
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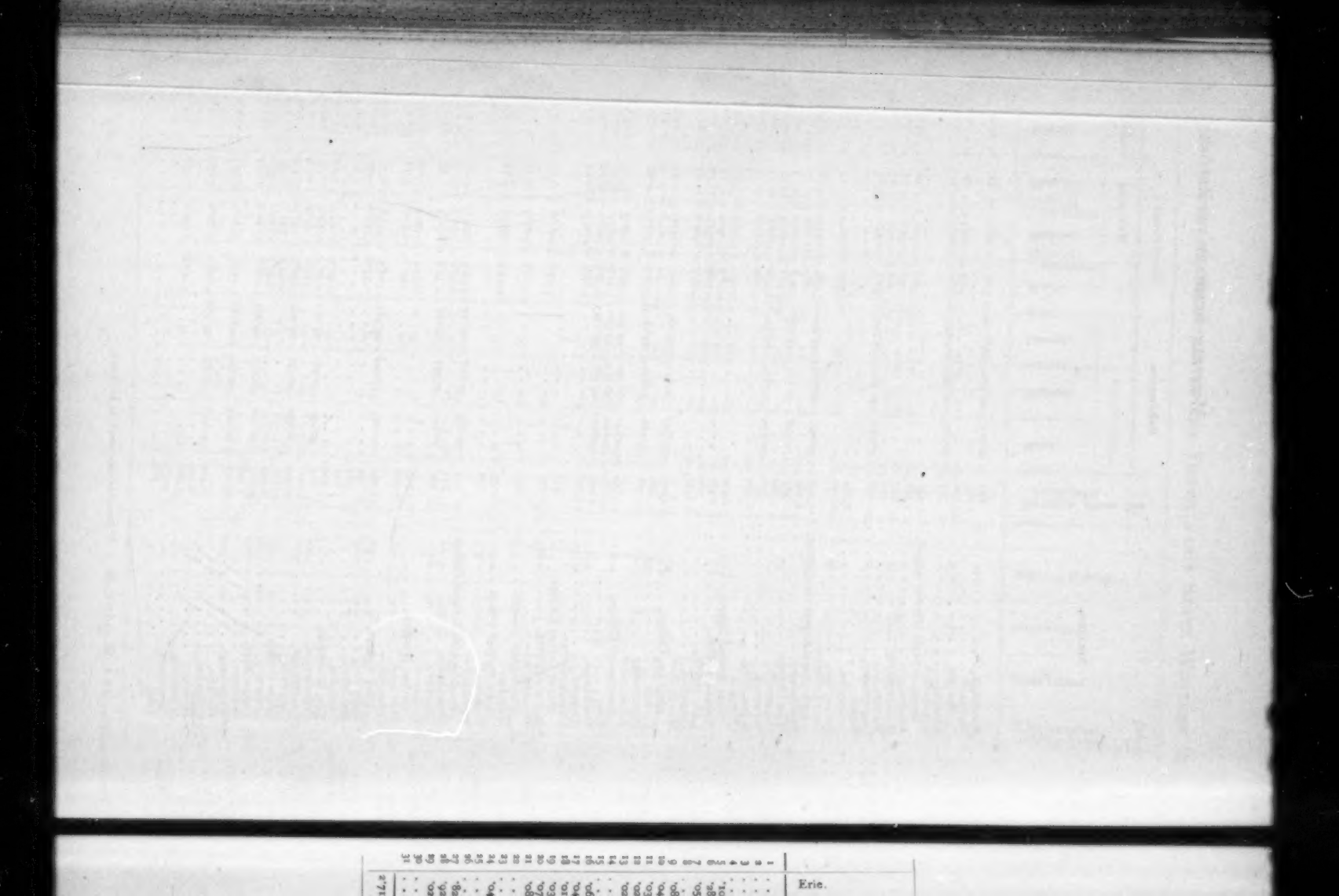
FOR JANUARY, 1889.

Number of Days Rainfall.	Number of Days.			Wind.			Observers.
				Prevailing Direction.			
	Clear.	Fair.	Cloudy.	7 A. M.	2 P. M.	9 P. M.	
14	4	8	19	W	W	W	Oscar D. Stewart, Sgt. Sig. Corps.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	Smith Curtis.
9	9	10	12	W	W	W	Rev. A. Thos. G. Apple.
9	12	9	10	NW	NW	NW	C. M. Dechant, C.E.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	Prof. J. H. Rohrbach.
7	. . .	. . .	. . .	. . .	. . .	. . .	Dr. Charles B. Dudley.
6	9	11	11	W	W	W	Prof. J. A. Stewart.
10	8	4	19	NW	NW	NW	Charles Beecher.
11	10	13	8	NW	NW	NW	J. L. Heacock.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	J. E. Forsythe.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	E. C. Lorentz.
10	5	11	15	W	W	W	T. B. Lloyd
7	9	12	10	W	W	W	Prof. Wm. Frear.
13	4	11	16	SW	SW	SW	Geo. H. Dunkle.
13	10	5	10	NW	NW	NW	Jesse C. Green, D.D.S.
13	15	5	11	W	W	W	W. T. Gordon.
8	9	15	7	W	W	W	
. . .	3	13	15	SE	SW	E	Rev. W. W. Deatrick, A.M
3	5	12	14	SW	SW	SW	C. M. Thomas, B.S.
14	4	13	14	W	W	W	Nathan Moore.
6	11	4	16	W	W	W	Prof. John A. Robb.
10	10	11	10	W	W	W	Robert M. Graham.
13	11	4	16	SW	S	S	R. B. Derickson.
12	9	10	12	W	W	W	J. E. Pague.
11	7	12	12	NW	NW	NW	Frank Ridgway, Sgt. Sig. Corps.
6	8	10	13	NW	NW	NW	Prof. Susan J. Cunningham
19	2	11	18	S	S	S	Peter Wood, Sgt Sig. Corps.
11	7	14	10	SW	W	W	Wm. Hunt.
14	5	7	19	W	W	W	Robert L. Haslet.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	P. C. Richardson.
7	13	7	11	W	W	NW	Thomas F. Sloan.
7	8	10	13	W	W	W	Prof. W. J. Swigart.
14	3	9	19	W	W	W	Prof. Albert E Maltby.
. . .	. .	. . .	. . .	. . .	. . .	. . .	J. F. Baumeister.
11	10	12	9	W	W	W	A. M. Schmidt, A.B.
7	3	7	21	SE	SE	SE	Wm. T. Butz.
11	11	9	11	NE	SW	SW	George W. Hayes C.E., Ph G.
8	. . .	. . .	. . .	. . .	. . .	. . .	H. D. Miller, M.D.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	Armstrong & Brownell.
14	2	8	21	SW	SW	SW	Prof S. H. Miller.
9	16	9	6	W	SW	W	Charles Moore, D.D.S.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	Lerch & Rice.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	G. R. Hanley.
6	15	5	11	W	W	W	Frank Mortimer.
11	14	6	11	W	W	NW	Luther M. Dey, Sgt. Sig. Corps.
11	11	5	14	W	W	W	C. L. Peck.
9	14	7	10	NW	NW	NW	E. C. Wagner.
8	5	12	14	NW	NW	NW	J. M. Boyer,
4	. . .	. . .	. . .	. . .	. . .	. . .	W. M. Schrock.
10	8	9	14	SW	SW	SW	E. S. Chase.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	A. H. Berlin.
14	4	8	19	S	SW	SW	H. D. Deming.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	Prof. N. P. Kinsley.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	Wm. Loveland.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	Theodore Day.
11	. . .	. . .	. . .	. . .	. . .	. .	John Torrey.
. . .	. .	. . .	. . .	. . .	. . .	. . .	H. S. Brunot.
. . .	. . .	. . .	. . .	. . .	. . .	. . .	Mrs. L. H. Grenewald.

T. F. TOWNSEND, *Sergeant Signal Corps, Assistant.*


Erie.

PRECIPITATION FOR JANUARY, 1889.

	Erie.	Greenville.	New Castle.	Meadville.	Columbus.	Pittsburgh.	Clarion.	Uniontown.	Indiana.	Somerset.	Grampian Hills.	Emporium.	Phillipsburg.	Huntingdon.	Hollidaysburg.	Altoona.	Charlesville.	State College.	McConnellsburg.	Lock Haven.	New Bloomfield.	Carlisle.	Wellsboro.	Harrisburg.	Selins Grove.	Wysox.	Eagles Mere.	Catawissa.	Girardville.	Lebanon.	Lancaster.	Difton.
1	. .	. .	. .	. .	.01	. .	. .	. .	. .	. .	. .		. .	.03	. .	. .	. .	. .	. .	.02	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
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5	.10	.52	.12	.58	. .	.38	. .	.16	. .	.55	. .	.18	.20	.30	.57	.24	1.12	. .	.81	.82	.75	.33	.60	.34	.80	.93	.76	.16	.39	.39	.39	.90	
6	.28	.27	.	.28	.60	.07		.07	.40	.18	.80	.39	.80	.44	.19	.42	.29	.78	.19	1.00	1.05	.85	1.40	.38	1.00	.28	. .	.70	.36	.20	.09	.42	
7	.05	.02	.55	.16	.06	.06	.64	. .	.01	. .	.06	.02	.02	. .	. .	. .	. .	. .	. .	. .	. .	. .	.05	.02	. .	.05	. .	. .	. .	. .	. .	.08	
8	. .	. .	. .	. .	. .	. .	. .	. .	.20	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	
9	.08	.39	.37	.95	.37	.29	.52	.28	.15	.58	.35	.30	.20	.62	.37	.25	.71	.33	.65	.38	.75	.43	1.64	.61	.90	.41	.86	.83	.95	.90	.44	.82	
10	.04	. .	. .	. .	.03	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.08	. .	. .	. .	. .	. .	.07	. .	. .	. .	. .	.11	. .	. .	. .	. .	. .	
11	.03	.05	.03	. .	.09	.02	.05	. .	. .	. .	.02	. .	.01	. .	. .	. .	. .	.02	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	
12	.02	. .	. .	. .	. .	.01	. .	. .	.05	. .	. .	. .	.02	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	
13	.02	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	
14	. .	. .	. .	. .	. .	. .	. .	.05	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	
15	. .	. .	. .	.11	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.03	. .	. .	. .	. .	. .	. .	
16	.06	.34	.35	.20	.35	.17	.29	. .	.20	. .	. .	. .	. .	. .	. .	. .	.07	. .	. .	. .	.15	. .	.40	.10	.10	. .	.51	.10	.31	.17	.08	.76	
17	.04	.04	. .	. .	. .	.05	. .	.22	. .	. .	.34	.28	.18	.16	. .	. .	.15	. .	.40	.08	.02	.55	. .	.52	.30	. .	. .	.34	.62	1.08	.47	.15	
18	.01	.01	. .	.20	.02	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.09	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	
19	.03	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	
20	.07	.29	. .	.30	.18	.20	. .	. .	.15	.50	. .	.50	. .	. .	.80	. .	.67	. .	.75	. .	. .	.01	. .	.22	. .	.42	1.19	.33	.63	.47	.32	.24	
21	.08	.29	. .	.45	.05	.20	. .	.13	.20	.30	.66	. .	.36	.59	. .	.45	.21	.20	. .	. .	. .	.71	1.16	.06	. .	. .	. .	. .	. .	.43	.48	. .	
22	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.02	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	
23	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	
24	.04	. .	.30	. .	.16	.09	. .	.03	.43	. .	.10	.11	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.05	. .	. .	. .	. .	. .	. .	. .	.10	. .	
25	. .	. .	. .	. .	. .	.01	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	
26	. .	. .	. .	. .	. .	. .	. .	.12	. .	.43	. .	. .	. .	. .	.04	. .	.06	. .	.06	. .	. .	.02	.30	.10	.10	.09	. .	.01	.08	.03	.05	. .	
27	.82	1.11	1.45	. .	1.00	.71	. .	.08	.75	.48	.55	.64	.32	.70	.59	.01	.53	.50	.42	1.18	.80	.34	1.10	.42	.70	.38	.59	.45	.32	.44	.31	.37	
28	.02	.09	. .	.35	.10	.13	. .	.04	.05	.30	.18	.18	.26	. .	. .	.35	. .	. .	. .	. .	. .	.04	.10	.01	.10	.10	.54	.10	. .	.04	. .	. .	
29	.02	.01	. .	.15	.03	.04	1.85	. .	.15	.12	. .	. .	.02	. .	. .	. .	. .	. .	. .	. .	. .	.05	. .	. .	. .	.01	. .	. .	. .	. .	. .	. .	
30	. .	. .	. .	.47	. .	. .	. .	. .	.10	. .	.04	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.02	. .	. .	. .	. .	. .	. .	. .	. .	. .	
31	. .	.09	. .	.05	.17	.07	. .	.26	.10	.04	.22	.15	. .	. .	. .	. .	. .	.05	.25	. .	. .	.09	.20	.08	. .	. .	.36	.20	.14	.11	.10	. .	
	2.71	3.52	3.17	4.25	3.22	2.50	3.35	2.34	2.94	3.48	3.32	2.75	2.41	2.84	2.56	1.82	3.81	1.97	3.53	3.48	3.52	3.49	7.02	2.86	4.00	2.72	4.92	3.22	3.80	4.21	2.83	3.74	3

IPITATION FOR JANUARY, 1889.

New Bloomfield.	Carlisle.	Wellsboro.	Harrisburg.	Selins Grove.	Wyson.	Eagles Mere.	Catawissa.	Girardville.	Lebanon.	Lancaster.	Drifton.	Reading.	Pottstown.	West Chester	Coatesville.	Honesdale.	Quakertown.	Swarthmore.	Philadelphia.	Coudersport.	Schelhrville.	Frederick.	Ottsville.
.	. .	. .	. .	. .	. .	.	. .	. .	. .	. .	. .	. .	. .	. .	. .	·01	. .	. .	. .	. .	. .	. .	. .
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·75	·33	·60	·34	·80	·93	·76	·16	·39	·39	·39	·90	·56	·40	·93	·71	·50	·46	. .	·41	. .	. .	. .	. .
·05	·85	1·40	·38	1·00	·28	. .	·70	·36	·20	·09	·42	.	·22	·23	·27	·82	·44	·73	·35	·60	·69	·47	·74
.	. .	·05	·02	. .	·05	. .	. .	. .	. .	. .	·28	·51	. .	. .	·01	·05	·01	. .	. .	. .	. .	. .	. .
.	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
·75	·43	1·64	·61	·90	·41	·86	·83	·93	·90	·44	·82	·72	·65	·72	·77	·44	·83	·54	·52	·60	·75	·69	·61
.	·07	. .	. .	. .	. .	·11	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
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.	. .	. .	. .	. .	·03	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
·15	. .	·40	·10	·10	. .	·51	·10	·31	·17	·08	·76	·17	·40	·11	·05	. .	·16	. .	·08	·40	. .	. .	. .
·02	·55	. .	·52	·30	. .	. .	·34	·62	1·08	·47	·15	·37	·15	·81	·62	·47	1·01	1·34	·95	. .	1·23	·72	1·04
.	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
.	·01	.	·22	. .	·42	1·19	·33	·63	·47	·32	·24	·50	1·60	·55	·62	·98	·50	1·44	·18	. .	. .	. .	1·41
.	·71	1·16	·06	. .	. .	. .	. .	. .	·43	·48	. .	·53	. .	·60	·69	. .	·51	. .	·90	·70	1·19	·98	. .
.	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	·20	. .	. .	. .
.	. .	·05	. .	. .	. .	. .	. .	. .	. .	·10	. .	·02	·20	·10	·10	·01	·07	. .	·06	·10	·03	·10	. .
.	·02	·30	·10	·10	·09	. .	·01	·08	·03	·05	. .	. .	. .	·03	·02	. .	. .	·17	·09	. .	. .	. .	. .
·80	·34	1·10	·42	·70	·38	·59	·45	·32	·44	·31	·37	·36	·43	·62	·44	·78	·38	·58	·38	1·50	·39	·44	·90
.	·04	·10	·01	·10	·10	·54	·10	. .	·04	. .	. .	. .	. .	·03	·01	. .	·01	. .	. .	. .	. .	. .	. .
.	·05	. .	. .	. .	·01	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	·03	. .	. .	. .	·50	. .	. .	. .
.	. .	·02	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
.	·09	·20	·08	. .	. .	·36	·20	·14	·11	·10	. .	. .	·05	·03	. .	·06	. .	. .	. .	·20	. .	·04	. .
52	3·49	7·02	2·86	4·00	2·70	4·92	3·22	3·80	4·21	2·83	3·74	3·74	4·12	4·78	4·33	4·15	4·58	4·80	3·75	4·80	4·28	3·44	4·30

| | | |

Lebanon, 9th; Philadelphia, 15th; Eagles Mere, 19th; Wellsboro, 8th, 15th.

Parhelia—Charlesville, 3d, 19th; Eagles Mere, 24th.

WEATHER SIGNALS.

Displayman.	*Station.*
U. S. Signal Office,	Philadelphia.
Wanamaker & Brown,	"
Pennsylvania Railroad Company,	"
Continental Brewing Company,	"
Samuel Simpson,	"
B. T. Babbitt,	"
Western Meat Company,	"
Neptune Laundry,	"
Chester Oil Company,	Chester.
C. W. Burkhart,	Shoemakerville.
A. N. Lindenmuth,	Allentown.
C. B. Whitehead,	Bradford.
Capt. Geo. R. Guss,	West Chester.
Werner & Son,	Emporium.
C. E. Lenhart,	Latrobe.
Thomas F. Sloan,	McConnellsburg.
J. H. Fulmer,	Muncy.
W. T. Butz,	New Castle.
S. W. Morrison,	Oxford.
Capt. A. Goldsmith,	Quakertown.
J. L. Morrison,	Sharon.
Wm. A. Engel,	Shenandoah.
Wm. Schrock,	Somerset.
Postmaster,	Meadville.
Frank Ross,	Oil City.
Lerch & Rice,	Bethlehem.
John W. Aitken,	Carbondale.
Signal Office,	Erie.
J. R. Raynsford,	Montrose.
E. P. Wilbur & Co.,	South Bethlehem.
Agricultural Experiment Station,	State College.
Signal Office,	Pittsburgh.
E. H. Baker,	Williamsport.
New Era,	Lancaster.
State Normal School,	Clarion.
Clarion Collegiate Institute,	Rimersburg.
E. S. Chase,	Eagles Mere.
Thiel College,	Greenville.
D. G. Hurley,	Altoona.
Armstrong & Brownell,	Smethport.
J. E. Forsythe,	Butler.

Displayman.	*Station.*
James H. Fones,	Tionesta.
Wister, Hacker & Savage,	Germantown.
W. J. Thompson & Co.,	Clifton Heights.
Steward M. Dreher,	Stroudsburg.
State Normal School,	Millersville.
E. C. Wagner,	Girardville.
Hartford P. Brown,	Rochester.
L. H. Grenewald,	York.
J. E. Pague,	Carlisle.
C. L. Peck,	Coudersport.
H. D. Miller,	Drifton.
Smith Curtis,	Beaver.
M. Tannehill,	Confluence.
S. C. Burkholder,	Pollock.
Robt. M. Graham,	Catawissa.
Henry F. Bitner,	Millersville.
A. J. Edelman,	Pottstown.
A. M. Wildman,	Langhorn.
N. E. Graham,	East Brady.
B. F. Gilmore,	Chambersburg.
Frank M. Morrow,	Altoona.
A. Simon's Sons,	Lock Haven.
E. W. McArthurs,	Meadville.
J. K. M. McGovern,	Lock No. 4.
Raftsman's Journal,	Clearfield.

PENNSYLVANIA STATE WEATHER SERVICE.

MONTHLY WEATHER REVIEW

FOR FEBRUARY, 1889.

Prepared under the Direction of the Committee on Meteorology of the FRANKLIN INSTITUTE.

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, February 28, 1889.

TEMPERATURE.

The mean temperature for February, obtained from the daily observations of forty-six stations, was 23°·0, which is 6° below the normal.

The mean daily maximum and minimum, 31°·3 and 14°·8 respectively, give a monthly mean of 23°·0.

Uniontown reports an average daily temperature of 30°·0, and Eagles Mere 12°·0, which are the two extremes.

The highest temperatures reported were Indiana, 60°; Uniontown, 58°; McConnellsburg and Phillipsburg each 56°. The lowest were Coudersport, minus 27°; Smethport, minus 27°; Columbus, minus 26°; Grampian Hills, minus 21°; Clarion, minus 21°; Emporium, 20°, and Wellsboro, minus 20°.

The low temperature occurred on the 24th.

BAROMETER.

The mean pressure for the month, 30·14, is ·05 above the normal. The highest pressure occurred during the cold period of the 24th, and the lowest on the 5th and 18th. Rain and snow storms attended these depressions.

PRECIPITATION.

The amount of rain and melted snow for the month averaged 1·96 inches, which is 1·25 inches less than the normal. The precipitation was evenly distributed throughout the state, and at quite regular intervals during the month. Snows were numerous, but soon melted in the agricultural districts. The greatest total snow falls in inches for the month were Eagles Mere, 28;

Smethport, 20; Phillipsburg, 18; Wellsboro, 18; Coudersport, 17, and Grampian Hills, 17. No heavy drifts occurred.

WIND AND WEATHER.

The prevailing wind was from the west. No severe gales occurred. Owing to the rapid melting of the snows, winter grain has been much exposed, but at the end of the month it had not been materially injured. The ice harvest was abundant.

Average number.—Rainy days, 9; clear days, 7; fair days, 9; cloudy days, 12.

MISCELLANEOUS PHENOMENA.

Snow.—Charlesville, 3d, 4th, 5th, 6th, 8th, 9th, 10th, 11th, 12th, 13th, 14th, 18th, 23d, 24th, 25th, 26th; Reading, 2d, 3d, 4th, 25th, 27th; Hollidaysburg, 2d, 3d, 5th, 6th, 7th, 8th, 11th, 18th, 26th; Wysox, 5th, 8th, 12th, 17th, 26th, 27th; Quakertown, 4th, 5th, 6th, 9th, 11th, 12th, 23d, 25th, 27th, 28th; Emporium, 1st, 5th, 8th, 9th, 11th, 16th, 18th, 27th; Phillipsburg, 1st, 2d, 3d, 4th, 5th, 6th, 7th, 10th, 11th, 12th, 13th, 14th, 15th, 20th, 24th, 26th, 28th; West Chester, 5th, 6th, 11th, 23d, 24th, 25th, 27th; Coatesville, 11th, 12th, 25th, 27th; Westtown, 5th, 11th, 25th, 28th; Rimersburg, 2d, 3d, 5th, 8th, 9th, 11th, 12th, 18th, 22d, 25th, 26th; Clarion, 2d, 3d, 5th, 8th, 11th, 12th, 18th, 26th; Grampian Hills, 2d, 5th, 7th, 11th, 16th, 18th, 26th; Lock Haven, 5th, 8th, 9th, 11th, 16th, 18th, 26th, 27th; Catawissa, 8th, 16th, 25th, 26th; Meadville, 5th, 6th, 7th, 8th, 9th, 10th, 11th, 12th, 21st, 26th, 27th; Carlisle, 9th, 11th, 27th; Swarthmore, 11th, 22d, 27th; Uniontown, 4th, 11th, 12th, 13th; McConnellsburg, 8th, 9th, 10th; Huntingdon, 11th, 27th; Indiana, 1st, 5th, 8th, 10th, 11th, 18th; Lancaster, 5th, 11th, 25th, 27th; New Castle, 8th, 12th, 18th, 23d, 26th; Lebanon, 3d, 4th, 5th, 9th, 11th, 12th, 25th, 27th; Drifton, 8th, 16th, 22d, 27th; Smethport, 1st, 2d, 3d, 5th, 8th, 9th, 10th, 11th, 12th, 16th, 17th, 18th; Greenville, 1st, 3d, 4th, 5th, 6th, 7th, 8th, 9th, 10th, 11th, 18th, 22d, 25th, 26th, 27th; Pottstown, 11th, 12th, 27th; Bethlehem, 5th, 8th, 12th, 16th, 18th, 27th; New Bloomfield, 8th, 9th, 11th, 27th; Coudersport, 2d, 3d, 8th, 9th, 10th, 11th, 12th, 18th, 27th; Girardville, 5th, 8th, 11th, 23d, 24th, 26th, 27th; Selins Grove, 8th, 11th, 26th, 27th; Somerset, 3d, 4th, 5th, 9th, 10th, 11th, 13th, 18th, 22d, 25th, 26th, 27th; Eagles Mere, 1st, 2d, 3d, 5th, 8th, 9th, 10th, 11th, 12th, 18th, 22d, 26th, 27th, 28th; Wellsboro, 1st, 2d, 3d, 4th, 5th, 6th, 8th, 11th, 12th, 16th, 17th, 18th, 22d, 26th, 27th; Columbus, 1st, 2d, 5th, 6th, 7th, 8th, 10th, 11th, 12th, 13th, 18th, 22d, 26th, 27th; Philadelphia,

Coronæ.—Charlesville, 9th; Hollidaysburg, 13th; Catawissa, 13th; Huntingdon, 10th; Lebanon, 6th, 7th, 9th, 10th, 12th, 13th, 14th, 15th; Greenville, 10th, 13th, 14th.

Solar Halos.—Charlesville, 21st; West Chester, 26th; Girardville, 24th; Eagles Mere, 13th, 24th, 26th.

Lunar Halos.—Charlesville, 7th, 10th, 13th, 14th; Reading, 13th; Hollidaysburg, 10th; West Chester, 10th; Carlisle, 9th, 10th; Lancaster, 13th;

Monthly Summary of Reports by Voluntary Observers of the Pennsylvania State Weat

County.	Station.	Elevation above Sea Level (feet).	Barometer.			Temperature.												Relative Humidity.	Dew Point.	Total Inches.
							Maximum.		Minimum.				Daily Range.							
			Mean.	Highest.	Lowest.	Mean.	Highest.	Date.	Lowest.	Date.	Mean of Maximum.	Mean of Minimum.	Mean.	Greatest.	Date.	Least.	Date.			
...sey,[1]	Pittsburgh,	847	30·118	30·750	29·370	27·3	53·0	17	— 1·0	24	34·9	21·2	13·7	32·0	5	6·0	6	72·6	19·2	1·58
...r,	Rochester	821	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...d,	Charlesville,	1,300	...	...	...	24·0	51·0	17	— 9·0	24	32·5	16·7	15·8	35·0	23	4·0	28	72·5	15·9	1·53
...[1]	Reading,	304	30·202	30·765	29·615	24·5	43·5	5	— 4·0	24	35·5	17·3	18·2	34·0	23	5·0	18	...	...	1·36
...	Kutztown—																			
	Keystone State Normal School,	540	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	Altoona,	1,181	...	...	...	30·0	51·0	18	— 3·0	24	39·1	20·9	18·2	34·0	23	7·0	3	69·8	21·5	1·24
...	Hollidayaburg,	947	...	...	...	24·0	49·0	22	— 7·0	24	33·0	15·0	16·0	34·0	21	5·0	6	81·0	19·0	1·91
...rd,	Wysox,	728	...	...	...	17·1	44·0	17	— 15·0	24	27·0	10·4	16·6	30·1	21	2·5	7	81·3	15·2	1·73
...	Forks of Neshaminy,	...	...	...	...	22·3	44·0	17	3·0	24	...	...	...	...	...	...	...	...	...	2·03
...	Point Pleasant,	...	...	...	...	22·2	34·5	17, 18	3·5	24	...	...	...	...	...	...	...	...	...	2·20
...	Quakertown,	536	30·120	30·820	29·460	24·3	46·0	17	— 4·5	24	34·3	15·4	18·9	28·7	21	7·5	18	83·8	15·3	2·38
...	Butler,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...ia,	Johnstown,	1,184	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...on,	Emporium,	1,030	...	...	...	21·8	45·0	22	— 20·0	24	31·3	8·5	22·8	50·0	21	7·0	23	...	...	1·61
...	State College—																			
	Agricultural Experiment Station,	1,191	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	Phillipsburg,	1,350	...	...	...	18·5	56·0	22	— 19·0	24	30·0	8·0	22·0	44·0	21	6·0	28	...	...	1·87
...	West Chester,	455	30·156	30·825	29·430	26·3	44·0	5, 7	— 2·0	24	26·6	19·3	7·3	25·5	23	2·0	28	70·0	17·8	2·46
...	Coatesville,	380	...	...	...	25·6	49·0	17	— 3·0	24	35·2	18·1	17·1	28·5	21	6·0	18	...	...	1·85
...r,[1]	Westtown,	550	30·250	30·900	29·630	25·4	47·0	5, 17	2·0	24	35·8	21·0	14·8	25·0	23	7·0	18	...	...	1·72
...n,	Rimersburg,	1,500	...	...	...	20·2	42·0	22, 28	— 13·0	24	27·2	12·7	14·5	28·0	22	4·0	27	...	...	...
...n,	Clarion—																			
	State Normal School,	1,530	...	...	...	20·0	46·5	17	— 21·0	24	29·2	11·4	17·8	34·1	21	2·5	14	84·3	15·0	2·10
...field,	Grampian Hills,	1,450	...	...	...	18·2	42·0	22	— 24·0	24	25·3	11·1	14·2	40·0	21	2·0	17	...	...	1·96
...n,	Lock Haven,	560	...	...	...	22·0	49·0	22	— 11·0	24	29·8	11·1	18·7	34·0	14	8·0	28	...	...	1·74
...bia,	Catawissa,	491	...	...	...	26·7	48·5	22	— 5·0	24	32·3	17·8	14·5	28·5	15	4·0	1	76·3	20·8	1·61
...ford,	Meadville—																			
	Allegheny College,	1,050	...	...	...	23·2	45·0	10	— 9·0	24	25·0	12·6	12·4	21·0	15	1·5	23	...	...	2·85
...berland,	Carlisle,	480	...	...	...	26·1	42·5	9	0·0	24	32·9	20·2	12·7	30·0	9	1·5	16	69·0	19·0	1·68
...hia,[1]	Harrisburg,	361	30·194	30·860	29·640	25·0	44·0	17	— 1·0	24	31·2	19·2	12·0	21·0	21	3·0	12	...	...	1·48
...ware,	Swarthmore—																			
	Swarthmore College,	190	30·185	30·742	29·505	28·1	47·8	5	6·5	24	35·7	21·5	14·2	25·1	23	6·7	18	79·0	21·0	1·92
...	Erie,	681	30·120	30·800	29·330	21·0	54·0	16	— 10·0	24	29·0	14·0	15·0	32·0	5	3·0	1	...	...	1·57
...te,	Uniontown,	1,000	30·070	30·599	29·414	30·0	58·0	16	— 1·0	24	36·2	19·8	17·4	26·0	16	6·0	28	73·0	22·0	2·43
...e,	Tionesta,	1,058	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...lin,[1]	Chambersburg—																			
	Wilson Female College,	618	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...n,	McConnellsburg,	875	...	...	...	26·4	56·0	17	2·0	24	36·7	15·2	17·5	40·0	23	5·0	16	80·0	20·7	1·65
...ngdon,	Huntingdon—																			
	The Normal College,	650	...	...	...	24·0	41·0	18	— 8·0	24	28·9	13·6	15·3	29·0	8	4·0	6	...	...	·97
...a,	Indiana—																			
	State Normal School,	1,350	...	...	...	26·4	60·0	18	— 11·0	24	32·9	18·5	13·4	32·0	21	2·0	20	84·5	22·6	2·42
...awanna,	Scranton,	750	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...aster,	Lancaster—																			
	Franklin and Marshall College,	413	30·164	30·815	29·457	26·4	44·0	3, 9	— 1·5	24	34·4	18·9	15·5	26·5	23	7·0	16	70·0	17·4	2·16
...ence,	New Castle,	932	...	...	...	24·7	50·0	17	— 11·0	24	32·7	14·5	18·2	37·0	5	5·0	27	88·2	20·2	3·33
...non,	Lebanon,	480	30·167	30·847	29·471	25·8	44·8	22	0·0	24	34·2	19·2	15·0	32·4	23	4·1	18	75·7	19·0	1·85
...me,	Drifton—																			
	Drifton Hospital,	1,655	...	...	...	18·7	47·0	...	— 13·0	...	32·0	10·1	21·9	33·0	...	11·0	...	...	...	1·46
...an,	Smethport,	1,500	...	...	...	20·8	43·0	22	— 27·0	24	28·8	8·1	20·7	47·0	21	5·0	6	...	...	2·72
...er,[1]	Greenville—																			
	Thiel College,	1,000	30·087	30·811	29·295	19·1	48·9	17	— 16·8	24	30·8	11·3	19·5	40·6	24	2·7	1	89·7	16·0	1·18
...gomery,	Pottstown,	150	...	...	...	23·5	44·0	9	0·0	24	33·0	21·0	12·0	26·0	14	1·0	18	69·0	15·0	1·92
...mpton,	Bethlehem,	360	...	...	...	27·0	42·0	17	— 1·0	24	33·0	19·0	14·0	39·0	22	9·0	24	71·0	20·0	1·94
...umberland,	Shamokin,	733	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	New Bloomfield,	400	...	...	...	22·3	51·0	17	0·5	24	32·2	14·0	18·2	36·0	2	6·0	28	...	...	1·24
...delphia,[1]	Philadelphia,	117	30·180	30·800	29·450	28·2	51·0	5	2·0	24	35·9	23·1	12·8	22·0	5	5·0	19	68·6	18·6	2·00
...	Coudersport,	1,670	...	...	...	17·8	44·0	12, 22	— 27·0	24	25·5	8·8	16·7	31·0	21	4·0	3	78·2	12·1	1·90
...ilkill,	Girardville,	1,000	30·214	30·776	29·845	23·1	41·0	17	— 4·0	24	30·0	15·2	14·8	22·0	21	8·0	17	...	...	1·66
...er,	Selins Grove,	445	...	...	...	24·8	46·0	17	— 4·0	24	32·7	11·8	20·9	28·0	14	2·0	19	80·0	19·0	1·52
...rset,	Somerset,	2,250	...	...	...	21·0	50·0	17	— 13·0	24	33·5	13·3	20·2	33·0	24	3·0	6	87·0	18·9	3·13
...an,	Eagles Mere,	2,060	30·198	30·892	29·554	12·0	40·0	17	— 17·0	24	23·2	8·8	14·4	29·0	23	3·0	3	61·7	6·5	3·87
...ehanna,	Montrose,	1,656	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	Wellsboro,	1,327	30·093	30·841	29·399	18·4	54·0	17	— 20·0	24	30·2	10·2	20·0	33·1	26	3·8	14	80·5	13·5	2·98
...go,	Franklin,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...n,	Columbus,	1,410	...	...	...	18·4	42·0	15	— 26·0	24	27·1	9·7	17·4	44·0	4	1·0	17	...	...	1·53
...e,	Dyberry,	1,100	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...e,	Honesdale,	1,000	...	...	...	16·0	39·0	17, 28	— 15·0	24	26·6	6·3	20·3	34·0	8	6·0	19	...	...	2·10
...moreland,	Greensburg,	1,075	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...[1]	York,	385	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

[1] Observations taken at 8 A. M. and 8 P. M. [2] Observations taken at 12 Noon.

Smethport, 20; Phillipsburg, 18; Wellsboro, 18; Coudersport, 17, and Grampian Hills, 17. No heavy drifts occurred.

WIND AND WEATHER.

The prevailing wind was from the west. No severe gales occurred. Owing to the rapid melting of the snows, winter grain has been much exposed, but at the end of the month it had not been materially injured. The ice harvest was abundant.

Average number.--Rainy days, 9; clear days, 7; fair days, 9; cloudy days, 12.

MISCELLANEOUS PHENOMENA.

Snow.—Charlesville, 3d, 4th, 5th, 6th, 8th, 9th, 10th, 11th, 12th, 13th, 14th, 18th, 23d, 24th, 25th, 26th; Reading, 2d, 3d, 4th, 25th, 27th; Hollidaysburg, 2d, 3d, 5th, 6th, 7th, 8th, 11th, 18th, 26th; Wysox, 5th, 8th, 12th, 17th, 26th, 27th; Quakertown, 4th, 5th, 6th, 9th, 11th, 12th, 23d, 25th, 27th, 28th; Emporium, 1st, 5th, 8th, 9th, 11th, 16th, 18th, 27th; Phillipsburg, 1st, 2d, 3d, 4th, 5th, 6th, 7th, 10th, 11th, 12th, 13th, 14th, 15th, 20th, 24th, 26th, 28th; West Chester, 5th, 6th, 11th, 23d, 24th, 25th, 27th; Coatesville, 11th, 12th, 25th, 27th; Westtown, 5th, 11th, 25th, 28th; Rimersburg, 2d, 3d, 5th, 8th, 9th, 11th, 12th, 18th, 22d, 25th, 26th; Clarion, 2d, 3d, 5th, 8th, 11th, 12th, 18th, 26th; Grampian Hills, 2d, 5th, 7th, 11th, 16th, 18th, 26th; Lock Haven, 5th, 8th, 9th, 11th, 16th, 18th, 26th, 27th; Catawissa, 8th, 16th, 25th, 26th; Meadville, 5th, 6th, 7th, 8th, 9th, 10th, 11th, 12th, 21st, 26th, 27th; Carlisle, 9th, 11th, 27th; Swarthmore, 11th, 22d, 27th; Uniontown, 4th, 11th, 12th, 13th; McConnellsburg, 8th, 9th, 10th; Huntingdon, 11th, 27th; Indiana, 1st, 5th, 8th, 10th, 11th, 18th; Lancaster, 5th, 11th, 25th, 27th; New Castle, 8th, 12th, 18th, 23d, 26th; Lebanon, 3d, 4th, 5th, 9th, 11th, 12th, 25th, 27th; Drifton, 8th, 16th, 22d, 27th; Smethport, 1st, 2d, 3d, 5th, 8th, 9th, 10th, 11th, 12th, 16th, 17th, 18th; Greenville, 1st, 3d, 4th, 5th, 6th, 7th, 8th, 9th, 10th, 11th, 18th, 22d, 25th, 26th, 27th; Pottstown, 11th, 12th, 27th; Bethlehem, 5th, 8th, 12th, 16th, 18th, 27th; New Bloomfield, 8th, 9th, 11th, 27th; Coudersport, 2d, 3d, 8th, 9th, 10th, 11th, 12th, 18th, 27th; Girardville, 5th, 8th, 11th, 23d, 24th, 26th, 27th; Selins Grove, 8th, 11th, 26th, 27th; Somerset, 3d, 4th, 5th, 9th, 10th, 11th, 13th, 18th, 22d, 25th, 26th, 27th; Eagles Mere, 1st, 2d, 3d, 5th, 8th, 9th, 10th, 11th, 12th, 18th, 22d, 26th, 27th, 28th; Wellsboro, 1st, 2d, 3d, 4th, 5th, 6th, 8th, 11th, 12th, 16th, 17th, 18th, 22d, 26th, 27th; Columbus, 1st, 2d, 5th, 6th, 7th, 8th, 10th, 11th, 12th, 13th, 18th, 22d, 26th, 27th; Philadelphia,

Coronæ.—Charlesville, 9th; Hollidaysburg, 13th; Catawissa, 13th; Huntingdon, 10th; Lebanon, 6th, 7th, 9th, 10th, 12th, 13th, 14th, 15th; Greenville, 10th, 13th, 14th.

Solar Halos.—Charlesville, 21st; West Chester, 26th; Girardville, 24th; Eagles Mere, 13th, 24th, 26th.

Lunar Halos.—Charlesville, 7th, 10th, 13th, 14th; Reading, 13th; Hollidaysburg, 10th; West Chester, 10th; Carlisle, 9th, 10th; Lancaster, 13th;

Monthly Summary of Reports by Voluntary Observers of the Pennsylvania State Weat

County.	Station.	Elevation above Sea Level (feet).	Barometer.			Temperature.												Relative Humidity.	Dew Point.	Total Inches.
							Maximum.		Minimum.				Daily Range.							
			Mean.	Highest.	Lowest.	Mean.	Highest.	Date.	Lowest.	Date.	Mean of Maximum.	Mean of Minimum.	Mean.	Greatest.	Date.	Least.	Date.			
Allegheny,[1]	Pittsburgh,	847	30·118	30·750	29·370	27·3	53·0	17	— 1·0	24	34·9	21·2	13·7	32·0	5	6·0	6	72·6	19·2	1·58
Beaver,	Rochester	821	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Bedford,	Charlesville,	1,300	. . .	. . .	. . .	24·0	51·0	17	— 9·0	24	32·5	16·7	15·8	35·0	23	4·0	28	72·5	15·9	1·53
Berks,[1]	Reading,	304	30·202	30·765	29·625	24·5	43·5	5	— 4·0	24	35·5	17·3	18·2	34·0	23	5·0	18	. . .	. . .	1·36
Berks,	Kutztown— Keystone State Normal School,	540	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Blair,[2]	Altoona,	1,181	. . .	. . .	. . .	30·0	51·0	18	— 3·0	24	39·1	20·9	18·2	34·0	23	7·0	3	69·8	21·5	1·24
Blair,	Hollidaysburg,	947	. . .	. . .	. . .	24·0	49·0	22	— 7·0	24	33·0	15·0	18·0	34·0	21	5·0	6	81·0	19·0	1·91
Bradford,	Wyaox,	718	. . .	. . .	. . .	17·1	44·0	17	—15·0	24	27·0	10·4	16·6	30·1	21	2·5	7	71·3	15·2	1·73
Bucks,	Forks of Neshaminy,	. . .	. . .	. . .	. . .	. . .	22·3	44·0	17	3·0	24	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	2·03
Bucks,	Point Pleasant,	. . .	. . .	. . .	. . .	. . .	22·2	34·5	17, 18	3·5	24	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	2·80
Bucks,	Quakertown,	536	30·120	30·820	29·460	24·3	46·0	17	— 4·5	24	34·3	15·4	18·9	28·7	21	7·5	18	83·8	15·3	2·38
Butler,	Butler,	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Cambria,	Johnstown,	1,184	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Cameron,	Emporium,	1,030	. . .	. . .	. . .	21·8	45·0	22	—20·0	24	31·3	8·5	22·8	50·0	21	7·0	23	. . .	. . .	1·64
Centre,	State College— Agricultural Experiment Station,	1,191	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Centre,	Phillipsburg,	1,350	. . .	. . .	. . .	18·5	56·0	22	—19·0	24	30·0	8·0	22·0	44·0	21	6·0	28	. . .	. . .	1·87
Chester,	West Chester,	455	30·156	30·825	29·430	26·3	44·0	5, 7	— 2·0	24	26·6	19·3	7·3	25·5	23	2·0	28	70·0	17·8	2·46
Chester,	Coatesville,	380	. . .	. . .	. . .	25·6	49·0	17	— 3·0	24	35·2	18·1	17·1	28·5	21	6·0	18	. . .	. . .	1·85
Chester,[1]	Westtown,	550	30·250	30·900	29·630	25·4	47·0	5, 17	2·0	24	35.8	21·0	14·8	25·0	23	7·0	18	. . .	. . .	1·72
Clarion,	Rimersburg,	1,500	. . .	. . .	. . .	20·2	42·0	22, 28	—13·0	24	27·2	12·7	14·5	28·0	22	4·0	27	. . .	. . .	. . .
Clarion,	Clarion— State Normal School,	1,530	. . .	. . .	. . .	20·0	46·5	17	—21·0	24	29·2	11·4	17·8	34·1	21	2·5	14	84·3	15·0	2·10
Clearfield,	Grampian Hills,	1,450	. . .	. . .	. . .	18·2	42·0	22	—24·0	24	25·3	11·1	14·2	40·0	21	2·0	17	. . .	. . .	1·96
Clinton,	Lock Haven,	560	. . .	. . .	. . .	22·0	49·0	22	—11·0	24	29·8	11·1	18·7	34·0	14	8·0	28	. . .	. . .	1·74
Columbia,	Catawissa,	491	. . .	. . .	. . .	26·7	48·5	22	— 5·0	24	32·3	17·8	14·5	28·5	15	4·0	1	76·3	20·8	1·61
Crawford,	Meadville— Allegheny College,	1,050	. . .	. . .	. . .	23·2	45·0	10	— 9·0	24	25·0	12·6	12·4	21·0	15	1·5	23	. . .	. . .	2·85
Cumberland,	Carlisle,	480	. . .	. . .	. . .	26·1	42·5	9	0·0	24	32·9	20·2	12·7	30·0	9	1·5	16	69·0	19·0	1·68
Dauphin,[1]	Harrisburg,	361	30·194	30·860	29·640	25·0	44·0	17	— 1·0	24	31·2	19·2	12·0	21·0	21	3·0	12	. . .	. . .	1·48
Delaware,	Swarthmore— Swarthmore College,	190	30·185	30·742	29·505	28·1	47·8	5	0·5	24	35·7	21·5	14·2	25·1	23	6·7	18	79·0	21·0	1·92
Erie,[1]	Erie,	681	30·120	30·800	29·330	21·0	54·0	16	—10·0	24	29·0	14·0	15·0	32·0	5	3·0	1	. . .	. . .	1·57
Fayette,	Uniontown,	1,000	30·070	30·599	29·414	30·0	58·0	16	— 1·0	24	36·2	19·8	17·4	26·0	16	6·0	28	73·0	22·0	2·43
Forest,	Tionesta.	1,058	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Franklin,[1]	Chambersburg— Wilson Female College,	618	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Fulton,	McConnellsburg,	875	. . .	. . .	. . .	26·4	56·0	17	2·0	24	36·7	15·2	17·5	40·0	23	5·0	16	80·0	20·7	1·65
Huntingdon,	Huntingdon— The Normal College,	630	. . .	. . .	. . .	24·0	41·0	18	— 8·0	24	28·9	13·6	15·3	29·0	8	4·0	6	. . .	. . .	·97
Indiana,	Indiana— State Normal School,	1,330	. . .	. . .	. . .	26·4	60·0	18	—11·0	24	32·9	18·5	13·4	32·0	21	2·0	20	84·5	22·6	2·42
Lackawanna,	Scranton,	750	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Lancaster,	Lancaster— Franklin and Marshall College,	413	30·164	30·815	29·457	26·4	44·0	3, 9	— 1·5	24	34·4	18·9	15·5	26·5	23	7·0	16	70·0	17·4	2·16
Lawrence,	New Castle,	932	. . .	. . .	. . .	24·7	50·0	17	—11·0	24	32·7	14·5	18·2	37·0	5	5·0	27	88·2	20·2	3·33
Lebanon,	Lebanon,	480	30·167	30·847	29·471	25·8	44·8	22	0·0	24	34·2	19·2	15·0	32·4	23	4·1	18	75·7	19·0	1·85
Luzerne,	Drifton— Drifton Hospital,	1,635	. . .	. . .	. . .	18·7	47·0	. . .	—13·0	. . .	32·0	10·1	21·9	33·0	. . .	11·0	. . .	. . .	. . .	1·46
McKean,	Smethport,	1,500	. . .	. . .	. . .	20·8	43·0	22	—27·0	24	28·8	8·1	20·7	47·0	21	5·0	6	. . .	. . .	2·72
Mercer,[1]	Greenville— Thiel College,	1,000	30·087	30·811	29·295	19·1	48·9	17	—16·8	24	30·8	11·3	19·5	40·6	24	2·7	1	89·7	16·0	1·18
Montgomery,	Pottstown,	150	. . .	. . .	. . .	23·5	44·0	9	0·0	24	33·0	21·0	12·0	26·0	14	1·0	18	69·0	15·0	1·92
Northampton,	Bethlehem,	360	. . .	. . .	. . .	27·0	49·0	17	— 1·0	24	33·0	19·0	14·0	39·0	22	9·0	24	71·0	20·0	1·94
Northumberland,	Shamokin,	733	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Perry,	New Bloomfield,	400	. . .	. . .	. . .	22·3	51·0	17	0·5	24	32·2	14·0	18·2	36·0	2	6·0	28	. . .	. . .	1·24
Philadelphia,[1]	Philadelphia,	117	30·180	30·800	29·450	28·2	51·0	5	2·0	24	35·9	23·1	12·8	22·0	5	5·0	19	68·6	18·6	2·00
Potter,	Coudersport,	1,670	. . .	. . .	. . .	17·8	44·0	12, 22	—27·0	24	25·5	8·8	16·7	51·0	21	4·0	3	78·2	12·1	1·90
Schuylkill,	Girardville,	1,000	30·214	30·776	29·845	23·1	41·0	17	— 4·0	24	30·0	15·2	14·8	22·0	21	8·0	17	. . .	. . .	1·66
Snyder,	Selins Grove,	445	. . .	. . .	. . .	24·8	46·0	17	— 4·0	24	32·7	11·8	20·9	28·0	14	2·0	19	80·0	19·0	1·52
Somerset,	Somerset,	2,250	. . .	. . .	. . .	21·0	50·0	17	—13·0	24	33·5	13·3	20·2	33·0	24	3·0	6	83·0	18·9	3·13
Sullivan,	Eagles Mere,	2,000	30·198	30·892	29·554	12·0	40·0	17	—17·0	24	23·2	8·8	14·4	29·0	23	3·0	3	61·7	6·5	3·87
Susquehanna,	Montrose,	1,656	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Tioga,	Wellsboro,	1,327	30·093	30·841	29·399	18·4	54·0	17	—20·0	24	30·2	10·2	20·0	33·1	26	3·2	14	80·5	13·5	2·98
Venango,	Franklin,	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Warren,	Columbus,	1,410	. . .	. . .	. . .	18·4	42·0	15	—26·0	24	27·1	9·7	17·4	44·0	4	1·0	17	. . .	. . .	1·53
Wayne,	Dyberry.	1,100	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Wayne,	Honesdale,	1,000	. . .	. . .	. . .	16·0	39·0	17, 28	—15·0	24	26·6	6·3	20·3	34·0	8	6·0	19	. . .	. . .	2·10
Westmoreland,	Greensburg,	1,075	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
York,[1]	York,	385	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .

[1] Observations taken at 8 A. M. and 8 P. M. [2] Observations taken at 12 Noon.

TEMPERATURE.											PRECIPITATION.				N
INIMUM.		Mean of Maximum.	Mean of Minimum.	DAILY RANGE.					Relative Humidity.	Dew Point.	Total Inches.	Total Snowfall During Month.	Depth of Snow on Ground at End of Month.	Number of Days Rainfall.	
	Date.			Mean.	Greatest.	Date.	Least.	Date.							Clear.
0	24	34·9	21·2	13·7	32·0	5	6·0	6	72·6	19·2	1·58	. . .	. . .	16	
.	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. .
0	24	32·5	16·7	15·8	35·0	23	4·0	28	72·5	15·9	1·53	3·80	. . .	10	4
0	24	35·5	17·3	18·2	34·0	23	5·0	18	. . .	. . .	1·36	1·00	. . .	7	11
.	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. .
0	24	39·1	20·9	18·2	34·0	23	7·0	2	69·8	21·5	1·24	. . .	. . .	9	. .
0	24	33·0	15·0	18·0	34·0	21	5·0	6	81·0	19·0	1·91	5·75	. . .	5	13
0	24	27·0	10·4	16·6	30·1	21	2·5	7	81·3	15·2	1·73	14·00	6·00	8	6
0	24	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	2·03	. . .	. . .	7	. .
3	24	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	2·20	. . .	. . .	8	. .
3	24	34·3	15·4	18·9	28·7	21	7·5	18	83·8	15·3	2·38	1·69	. . .	11	6
.	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. .
.	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. .
0	24	31·3	8·5	22·8	50·0	21	7·0	23	. . .	. . .	1·61	13·35	7·00	8	3
.	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. .
0	24	30·0	8·0	22·0	44·0	21	6·0	28	. . .	. . .	1·87	17·75	2·00	19	2
0	24	26·6	19·3	7·3	25·5	23	2·0	28	70·0	17·8	2·46	3·50	1·00	12	12
0	24	35·2	18·1	17·1	28·5	21	6·0	18	. . .	. . .	1·85	4·60	1·00	9	10
0	24	35·8	21·0	14·8	25·0	23	7·0	18	. . .	. . .	1·72	5·50	1·00	9	12
0	24	27·2	12·7	14·5	28·0	22	4·0	27	. . .	. . .	. . .	15·50	2·00	11	6
0	24	29·2	11·4	17·8	34·1	21	2·5	14	84·3	15·0	2·10	. . .	. . .	. . .	. .
0	24	25·3	11·1	14·2	40·0	21	2·0	17	. . .	. . .	1·96	17·00	12·00	7	4
0	24	29·8	11·1	18·7	34·0	14	8·0	28	. . .	. . .	1·74	3·50	. . .	9	11
0	24	32·3	17·8	14·5	28·5	15	4·0	1	76·3	20·8	1·61	6·50	. . .	9	10
0	24	25·0	12·6	12·4	21·0	15	1·5	23	. . .	. . .	2·85	9·75	1·00	11	5
0	24	32·9	20·2	12·7	30·0	9	1·5	16	69·0	19·0	1·68	4·25	. . .	11	4
0	24	31·2	19·2	12·0	21·0	21	3·0	12	. . .	. . .	1·48	. . .	. . .	. . .	5
5	24	35·7	21·5	14·2	25·1	23	6·7	18	79·0	21·0	1·92	1·70	1·00	5	1
0	24	23·0	14·0	15·0	32·0	5	3·0	1	. . .	. . .	1·57	. . .	. . .	20	1
0	24	36·2	19·8	17·4	26·0	16	6·0	28	73·0	22·0	2·43	6·00	. . .	7	3
.	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. .
.	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. .
0	24	36·7	19·2	17·5	40·0	23	5·0	16	80·0	20·7	1·65	2·50	. . .	6	8
0	24	28·9	13·6	15·3	29·0	8	4·0	6	. . .	. . .	·97	3·20	. . .	4	6
0	24	32·9	18·5	13·4	32·0	21	2·0	20	84·5	22·6	2·42	4·10	. . .	10	4
.	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. .
5	24	34·4	18·9	15·5	26·5	23	7·0	16	70·0	17·4	2·16	4·00	. . .	8	1
0	24	32·7	14·5	18·2	37·0	5	5·0	27	88·2	20·2	3·33	10·75	. . .	6	3
0	24	34·2	19·2	15·0	32·4	23	4·1	18	75·7	19·0	1·85	5·50	. . .	11	6
0	. . .	32·0	10·1	21·9	33·0	. . .	11·0	. . .	. . .	. . .	1·46	8·50	. . .	5	. .
0	24	28·8	8·1	20·7	47·0	21	5·0	6	. . .	. . .	2·72	19·75	. . .	12	3
8	24	30·8	11·3	19·5	40·6	24	2·7	1	89·7	16·0	1·18	14·00	. . .	13	5
0	24	33·0	21·0	12·0	26·0	14	1·0	18	69·0	15·0	1·92	2·00	. . .	6	13
0	24	33·0	19·0	14·0	39·0	22	9·0	24	71·0	20·0	1·94	4·00	. . .	6	10
.	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. .
5	24	32·2	14·0	18·2	36·0	2	6·0	28	. . .	. . .	1·24	6·30	0·50	7	13
0	24	35·9	23·1	12·8	22·0	5	5·0	19	68·6	18·6	2·00	3·40	. . .	10	3
0	24	25·5	8·8	16·7	51·0	21	4·0	3	78·2	12·1	1·90	10·50	8·00	7	5
0	24	30·0	15·2	14·8	22·0	21	8·0	17	. . .	. . .	1·66	12·00	3·00	9	12
0	24	32·7	11·8	20·9	28·0	14	2·0	19	80·0	19·0	1·52	2·80	1·00	4	12
0	24	33·5	13·3	20·2	33·0	24	3·0	6	83·0	18·9	3·13	15·70	3·00	15	5
0	24	23·2	8·8	14·4	29·0	23	3·0	3	61·7	6·5	3·87	28·50	23·00	9	6
.	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. .
0	24	30·2	10·2	20·0	33·1	26	3·2	14	80·5	13·5	2·98	17·55	12·50	15	3
.	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. .
0	24	27·1	9·7	17·4	44·0	4	1·0	17	. . .	. . .	1·53	. . .	4·00	13	4
.	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. .
0	24	26·6	6·3	20·3	34·0	8	6·0	19	. . .	. . .	2·10	. . .	. . .	11	2
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	Number of Days.			Wind.			
				Prevailing Direction.			
Number of Days Rainfall.	Clear.	Fair.	Cloudy.	7 A. M.	2 P. M.	9 P. M.	Observers.
16	1	12	15	W	W	W	Oscar D. Stewart, Sgt. Sig. Corps.
...	...	...	...	...	...	...	Smith Curtis.
10	4	10	14	NW	W	SW	Rev. A. Thos. G. Apple.
7	12	7	9	NW	NW	NW	C. M. Dechant, C.E.
...	...	...	...	...	...	...	Prof. J. H. Rohrbach.
9	...	...	...	W	W	W	Dr. Charles B. Dudley.
5	13	5	10	...	...	...	Prof. J. A. Stewart.
8	6	10	12	NW	NW	NW	Charles Beecher.
7	...	...	...	W	NW	W	
8	...	...	...	...	...	...	
11	6	12	10	NW	NW	NW	J. L. Heacock.
...	...	...	...	...	...	...	J. E. Forsythe.
...	...	...	...	...	...	...	E. C. Lorentz.
8	3	14	11	W	W	W	T. B. Lloyd.
...	...	...	...	...	...	...	Prof. Wm. Frear.
19	8	4	16	SW	SW	SW	Geo. H. Dunkle.
12	12	8	8	W	W	W	Jesse C. Green, D.D.S.
9	10	6	12	W	W	W	W. T. Gordon.
9	12	8	8	W	W	W	
11	0	16	12	SW	W	NW	Rev. W. W. Deatrick, A.M.
...	...	...	...	SW	SW	SW	C. M. Thomas, B.S.
7	4	10	14	W	W	W	Nathan Moore.
9	12	9	11	N	W	W	Prof. John A. Robb.
9	10	8	10	N	NW	W	Robert M. Graham.
11	9	8	11	W	W	W	R. B. Derickson.
11	4	12	12	W	W	W	J. E. Pague.
...	9	5	14	NW	NW	NW	Frank Ridgway, Sgt. Sig. Corps.
5	3	8	17	...	...	...	Prof. Susan J. Cunningham.
20	3	7	18	...	...	...	Peter Wood, Sgt. Sig. Corps.
7	6	12	10	NW	NW	NW	Wm. Hunt.
...	...	...	...	...	...	...	Robert L. Haslet.
...	...	...	...	...	...	...	P. C. Richardson.
6	8	9	11	N	NW	NW	Thomas F. Sloan.
4	6	14	8	W	W	W	Prof. W. J. Swigart.
10	4	9	15	W	W	W	Prof. Albert E. Maltby.
...	...	...	...	...	...	...	J. F. Baumeister.
8	7	9	12	W	W	W	A. M. Schmidt, A.B.
6	7	7	14	NW	NW	NW	Wm. T. Butz.
11	6	13	9	SW	NW	NE	George W. Hayes, C.E., Ph.G.
5	...	...	...	...	...	...	H. D. Miller, M.D.
12	3	7	18	SW	SW	SW	Armstrong & Brownell.
13	5	16	7	NW	NW	SW	Prof. S. H. Miller.
6	13	6	9	NW	W	W	Charles Moore, D.D.S.
6	10	8	13	W	NW	W	Lerch & Rice.
...	...	...	...	...	...	...	G. R. Hanley.
7	13	7	8	W	W	W	Frank Mortimer.
10	3	12	13	NW	NW	NW	Luther M. Dey, Sgt. Sig. Corps.
7	5	10	13	W	W	W	C. L. Peck.
9	12	7	9	NW	NW	NW	E. C. Wagner.
4	12	9	7	SW	SW	SW	J. M. Boyer.
15	6	12	10	NW	NW	NW	W. M. Schrock.
9	6	10	12	SW	SW	SW	E. S. Chase.
...	...	...	...	...	...	...	A. H. Berlin.
15	3	7	18	SW	W	W	H. D. Deming.
...	...	...	...	...	...	...	Prof. N. P. Kinsley.
13	4	7	17	SW	SW	SW	Wm. Loveland.
...	...	...	...	...	...	...	Theodore Day.
11	...	...	...	...	...	...	John Torrey.
...	...	...	...	...	...	...	H. S. Brunot.
...	...	...	...	...	...	...	Mrs. L. H. Grenewald.

T. F. Townsend, *Sergeant Signal Corps, Assistant.*

	Erie.
1	88
2	88
3	. .
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13	. .
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PRECIPITATION FOR FEBRUARY. 1889

	Erie.	Greenville.	New Castle.	Columbus.	Pittsburgh.	Uniontown.	Indiana.	Somerset.	Grampian Hills.	Emporium.	Phillipsburg.	Huntingdon.	Hollidaysburg.	Altoona.	Charlesville.	McConnellsburg.	Lock Haven.	New Bloomfield.	Carlisle.	Wellsboro.	Harrisburg.	Selins Grove.	Wysox.	Eagles Mere.	Catawissa.	Girardville.	Lebanon.	Lancaster.	Drifton.	Reading.	Bethlehem.
1	·02	. .	. .	·06	·02	. .	·01	·15	. .	·04	·14	. .	. .	. .	. .	. .	. .	. .	. .	·05	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
2	·06	. .	. .	·03	. .	. .	. .	. .	·12	. .	·01	. .	. .	·03	. .	. .	. .	. .	. .	·05	. .	. .	. .	·28	. .	. .	. .	. .	. .	. .	. .
3	·08	. .	. .	. .	·03	. .	. .	·06	. .	. .	. .	. .	. .	. .	·01	. .	. .	. .	. .	·05	·01	. .	. .	. .	. .	. .	·01	. .	. .	. .	. .
4	. .	. .	. .	. .	·01	·11	. .	·03	. .	. .	·02	. .	. .	. .	. .	. .	. .	. .	·01	·02	. .	. .	. .	. .	. .	. .	·01	. .	. .	. .	. .
5	. .	·02	2·00	·16	·14	·21	·05	·05	·24	·20	·03	. .	·10	·02	·02	. .	·55	·20	·07	·30	·08	·23	·15	·74	·04	·28	·20	·10	. .	·24	·23
6	·14	. .	. .	. .	·01	. .	. .	. .	. .	. .	·10	. .	. .	. .	. .	. .	. .	. .	·07	·02	. .	. .	. .	. .	. .	. .	. .	. .	. .	·02	. .
7	·03	·01	. .	. .	·01	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
8	·08	·14	·15	·14	·10	·14	·10	·45	·23	·08	·01	. .	. .	. .	·07	·10	·10	·10	. .	·12	. .	·15	·19	·35	·20	·09	. .	. .	·27	. .	·02
9	·06	·10	. .	. .	. .	. .	. .	·09	. .	·10	·13	. .	. .	·06	·02	·15	·05	·06	·08	. .	·03	. .	. .	. .	. .	. .	·03	. .	. .	. .	. .
10	·05	·14	. .	·25	. .	. .	·20	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
11	·06	·17	. .	·20	·09	. .	·15	·25	·25	·19	·02	·34	·53	·14	·08	. .	·10	·42	·10	·27	·08	·21	. .	·74	·16	·12	·13	·11	. .	·03	. .
12	·14	. .	·40	·08	·03	. .	. .	·22	. .	. .	·11	. .	·05	·04	·01	. .	. .	. .	·05	·15	. .	. .	·05	. .	. .	. .	·01	. .	. .	. .	·08
13	. .	. .	. .	·04	·01	. .	. .	. .	. .	. .	·01	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
14	. .	. .	. .	. .	. .	·16	. .	·07	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
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16	·06	·20	. .	·15	·35	·70	1·60	·60	·44	·15	·15	·09	·58	. .	·51	·65	·02	·06	·15	·20	·20	·74	·30	·46	·54	·63	·67	·60	·45	·75	·83
17	·02	. .	. .	. .	·02	. .	·10	·15	. .	. .	·40	. .	. .	·43	·34	·24	·47	. .	·40	·05	·22	. .	·53	. .	·01	. .	·06	·21	·26	·03	. .
18	·23	·10	·15	·15	·67	·76	·15	·76	·56	·74	·50	43	·65	·44	·42	·44	·20	·35	·60	1·52	·71	·15	·10	·38	·24	·31	·50	·39	. .	·40	·56
19	·04	. .	. .	. .	. .	. .	. .	. .	. .	. .	·05	. .	. .	·03	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
20	·12	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
21	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
22	·09	·05	. .	·03	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	·05	. .	. .	. .	·12	. .	. .	. .	. .	·14	. .	. .
23	·04	. .	·30	. .	·03	. .	. .	·07	. .	. .	·02	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	·03	. .	. .	. .	. .	. .
24	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	·04	. .	. .	. .	. .	. .
25	·01	·01	. .	. .	·01	. .	. .	·03	. .	. .	·03	. .	. .	. .	. .	. .	. .	. .	. .	. .	·01	. .	. .	. .	·15	. .	·01	·50	. .	. .	. .
26	·07	·02	. .	·11	. .	. .	·01	. .	·12	. .	·01	. .	. .	. .	. .	. .	·10	. .	. .	·03	. .	. .	·37	·34	·10	·05	. .	. .	. .	. .	. .
27	·17	·21	·33	·13	·05	·37	·05	·15	. .	·11	·06	·11	. .	·05	·05	·07	·15	·05	·10	·10	·14	. .	·04	·46	·17	·11	·22	·24	·34	·15	·22
28	. .	·01	. .	. .	. .	. .	. .	. .	. .	. .	·03	. .	. .	. .	. .	. .	. .	. .	·05	. .	. .	·04	. .	. .	. .	. .	. .	·01	. .	. .	. .	. .
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31	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
	1·57	1·18	3·33	1·53	1·58	2·43	2·42	3·13	1·96	1·61	1·87	·97	1·91	1·24	1·53	1·65	1·74	1·24	1·68	2·98	1·48	1·52	1·73	3·87	1·61	1·66	1·85	2·16	1·46	1·62	1·94

PRECIPITATION FOR FEBRUARY. 1889

	Wellsboro.	Harrisburg.	Selins Grove.	Wysox.	Eagles Mere.	Catawissa.	Girardville.	Lebanon.	Lancaster.	Drifton.	Reading.	Bethlehem.	Pottstown.	West Chester.	Westtown	Coatesville.	Honesdale.	Quakertown.	Swarthmore.	Philadelphia.	Coudersport.	Schuylerville.
	.05	. .	. .	. .	.	. .	. .	. .	. .	. .	. .	. .	. .	.01	.01	. .	. .	. .	. .	. .	. .	. .
	.05	. .	. .	. .	.28	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.30	. .
	.05	.01	. .	. .	. .	. .	. .	.01	. .	. .	. .	. .	. .	. .	. .	. .	.01	. .	. .	. .	. .	. .
	.02	. .	. .	. .	. .	. .	. .	.01	. .	. .	. .	. .	. .	.01	. .	. .	. .	. .	. .	. .	. .	. .
7	.30	.08	.23	.15	.74	.04	.28	.20	.10	. .	.24	.23	.15	.14	.04	.20	.20	.23	. .	.08	. .	.33
7	.02	. .	. .	. .	. .	. .	. .	. .	. .	. .	.02	. .	. .	.05	. .	.02	. .	.05	.12	. .	. .	. .
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	.12	. .	.15	.19	.35	.20	.09	. .	. .	.27	. .	.02	. .	. .	. .	. .	.23	. .	. .	. .	.20	. .
8	. .	.03	. .	. .	. .	. .	. .	.03	. .	. .	. .	. .	. .	. .	. .	. .	. .	.07	. .	. .	.30	. .
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0	.27	.08	.21	.	.74	.16	.12	.13	.11	. .	.03	. .	.05	.14	. .	.10	.18	.07	. .	.14	.10	.23
5	.15	. .	. .	.05	. .	. .	. .	.01	. .	. .	. .	.08	.07	.03	.03	.01	.07	.04	. .	. .	.30	. .
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5	.20	.20	.74	.30	.46	.54	.63	.67	.60	.45	.75	.83	.80	.98	.88	.62	.65	.92	.98	.93	. .	.29
0	.05	.22	. .	.53	. .	.01	. .	.06	.21	.26	.03	. .	. .	.05	. .	.04	.07	.10	.02	.01	. .	. .
0	1.52	.71	.15	.10	.38	.24	.31	.50	.39	. .	.40	.56	.45	.61	.50	.40	.34	.57	.53	.42	.60	1.02
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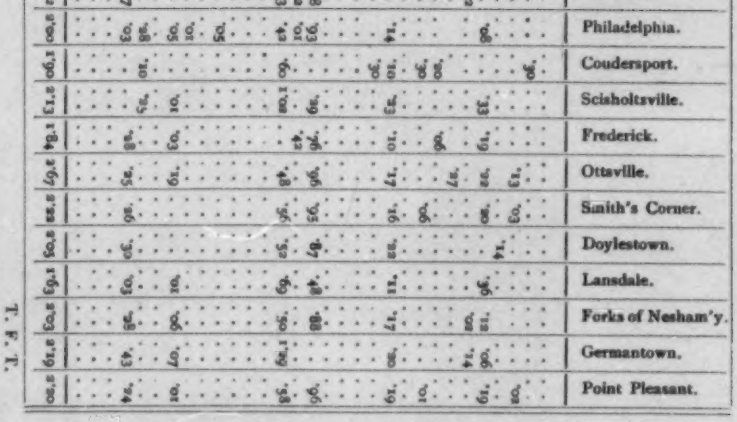
	.05	. .	. .	. .	.12	. .	. .	. .	. .	.14	. .	. .	. .	. .	. .	. .	. .	. .	. .	.05	. .	. .
	. .	. .	. .	. .	. .	. .	.03	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
	. .	. .	. .	. .	. .	. .	.04	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.01	. .	. .
	. .	.01	. .	. .	. .	.15	. .	.01	.50	. .	. .	. .	. .	.07	. .	.10	.02	.04	. .	.05	. .	.01
	.03	. .	. .	.37	.34	.10	.05	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
0	.10	.14	. .	.04	.46	.17	.11	.22	.24	.34	.15	.22	.40	.32	. .	.36	.27	.21	. .	.28	.10	.25
5	. .	. .	.04	. .	. .	. .	. .	. .	.01	. .	. .	. .	. .	.05	.26	. .	.06	.08	.27	.03	. .	. .
	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
8	2.98	1.48	1.52	1.73	3.87	1.61	1.66	1.85	2.16	1.46	1.62	1.94	1.92	2.46	1.72	1.85	2.10	2.38	1.92	2.00	1.90	2.13



00.0	Philadelphia.
06.1	Coudersport.
13.2	Scisholtsville.
14.1	Frederick.
19.2	Ottsville.
22.0	Smith's Corner.
30.0	Doylestown.
39.1	Lansdale.
50.5	Forks of Nesham'y.
61.2	Germantown.
66.0	Point Pleasant.

T. F. T.

Lebanon, 13th; Greenville, 10th, 14th; Selins Grove, 14th; Somerset, 10th, 14th; Eagles Mere, 13th.

Parhelias.—Eagles Mere, 15th, 24th, 25th.

WEATHER SIGNALS.

Displayman.	*Station.*
U. S. Signal Office,	Philadelphia.
Wanamaker & Brown,	"
Pennsylvania Railroad Company,	"
Continental Brewing Company,	"
Samuel Simpson,	"
B. T. Babbitt,	"
Western Meat Company,	"
Neptune Laundry,	"
Chester Oil Company,	Chester.
C. W. Burkhart,	Shoemakerville.
A. N. Lindenmuth,	Allentown.
C. B. Whitehead,	Bradford.
Capt. Geo. R. Guss,	West Chester.
Werner & Son,	Emporium.
C. E. Lenhart,	Latrobe.
Thomas F. Sloan,	McConnellsburg.
J. H. Fulmer,	Muncy.
W. T. Butz,	New Castle.
S. W. Morrison,	Oxford.
Capt. A. Goldsmith,	Quakertown.
J. L. Morrison,	Sharon.
Wm. A. Engel,	Shenandoah.
Wm. Schrock,	Somerset.
Postmaster,	Meadville.
Frank Ross,	Oil City.
Lerch & Rice,	Bethlehem.
John W. Aitken,	Carbondale.
Signal Office,	Erie.
J. R. Raynsford,	Montrose.
E. P. Wilbur & Co.,	South Bethlehem.
Agricultural Experiment Station,	State College.
Signal Office,	Pittsburgh.
E. H. Baker,	Williamsport.
New Era,	Lancaster.
State Normal School,	Clarion.
Clarion Collegiate Institute,	Rimersburg.
E. S. Chase,	Eagles Mere.
Thiel College,	Greenville.
D. G. Hurley,	Altoona.
Armstrong & Brownell,	Smethport.
J. E. Forsythe,	Butler.

Displayman.	*Station.*
James H. Fones,	Tionesta.
Wister, Hacker & Savage,	Germantown.
W. J. Thompson & Co.,	Clifton Heights.
Steward M. Dreher,	Stroudsburg.
State Normal School,	Millersville.
E. C. Wagner,	Girardville.
Hartford P. Brown,	Rochester.
L. H. Grenewald,	York.
J. E. Pague,	Carlisle.
C. L. Peck,	Coudersport.
H. D. Miller,	Drifton.
Smith Curtis,	Beaver.
M. Tannehill,	Confluence.
S. C. Burkholder,	Pollock.
Robt. M. Graham,	Catawissa.
Henry F. Bitner,	Millersville.
A. J. Edelman,	Pottstown.
A. M. Wildman,	Langhorn.
N. E. Graham,	East Brady.
B. F. Gilmore,	Chambersburg.
Frank M. Morrow,	Altoona.
A. Simon's Sons,	Lock Haven.
E. W. McArthurs,	Meadville.
J. K. M. McGovern,	Lock No. 4.
Raftsman's Journal,	Clearfield.

PENNSYLVANIA STATE WEATHER SERVICE.

MONTHLY WEATHER REVIEW

FOR MARCH, 1889.

Prepared under the Direction of the Committee on Meteorology of the FRANKLIN INSTITUTE.

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, March 31, 1889.

TEMPERATURE.

The mean temperature for March, 1889, 38°·9, is from 2° to 3° above the normal, and 7°·8 above that of March, 1888.

The mean, determined from the daily maxima and minima, is 39°·0.

The following stations report the highest average daily temperatures: New Castle, 45°·3; Selins Grove, 44°·0; Indiana, 43°·2, and Pottstown, 43°·0. The highest temperatures noted on any one day were Columbus, 76°·0; Pittsburgh, 70°·0, and Rimersburg, 70°·0. The lowest were Columbus, 4°·0; Somerset, 9°·0; New Castle, 9°·0, and Clarion, 9°·0. The coldest day of the month was on the 30th, but the low temperatures that generally occur in March were not reached. The entire month has been characterized by mildness.

BAROMETER.

The mean barometer, 29·95, is about ·07 below the average. The highest pressure occurred on the 1st, and the lowest on the 7th.

PRECIPITATION.

The average precipitation (rain and melted snow), 2·90 inches, is a deficiency of a little over one-half inch. The distribution was uneven. The largest totals reported for the month were West Chester, 5·44 inches; McConnellsburg, 4·76 inches; Coatesville, 4·49 inches, and Ottsville, 4·42 inches. Several stations report less than 2 inches.

The greatest total snowfall in inches were Charlesville, 11·50; Eagles Mere, 9·60; Girardville, 8·00, and Somerset, 7·80.

Very few stations reported snow on the ground at the end of the month.

WIND AND WEATHER.

The prevailing wind direction was from the northwest.

The weather for March was unusually fine. Notwithstanding the lack of snow, winter grain appears to have been injured very little. Frosts were numerous, but caused little damage.

Average number.—Rainy days, 9; clear days, 10; fair days, 8; cloudy days, 13.

MISCELLANEOUS PHENOMENA.

Thunder Storms.—Charlesville, 31st; Quakertown, 27th; Grampian Hills, 31st; Carlisle, 27th; Erie, 31st; McConnellsburg, 27th, 31st; Huntingdon, 31st; Lancaster, 27th; Pottstown, 27th; New Bloomfield, 31st; Girardville, 27th; Somerset, 31st.

Snow.—Charlesville, 3d, 4th, 5th, 6th, 7th, 8th, 9th, 10th, 21st; Wysox, 7th, 9th, 20th, 29th; Emporium, 21st, 22d, 29th, 31st; Phillipsburg, 3d, 10th, 21st, 22d; West Chester, 21st, 30th, 31st; Coatesville, 10th, 21st, 28th, 30th, 31st; Rimersburg, 3d, 6th, 8th, 9th, 10th, 21st, 22d, 28th, 29th; Grampian Hills, 21st, 22d; Lock Haven, 21st, 31st; Catawissa, 29th, 31st; Carlisle, 31st; Uniontown, 9th, 10th, 28th, 30th; Lancaster, 8th, 20th, 21st, 30th, 31st; New Castle, 10th, 19th; Lebanon, 9th, 10th, 21st, 31st; Pottstown, 29th, 31st; New Bloomfield, 31st; Philadelphia, 8th, 9th, 10th, 21st, 30th, 31st; Girardville, 9th, 20th, 21st, 29th, 31st; Selins Grove, 8th, 9th, 10th, 21st, 29th, 31st; Somerset, 3d, 4th, 6th, 9th, 10th, 21st, 29th; Eagles Mere, 4th, 8th, 9th, 10th, 29th, 31st; Wellsboro, 21st, 29th, 31st; Columbus, 7th, 8th, 9th, 28th, 29th, 30th, 31st; Dyberry, 20th, 21st, 31st.

Coronæ.—Hollidaysburg, 3d, 7th, 8th, 9th, 19th, 21st, 29th; Rimersburg, 16th; Indiana, 14th; Eagles Mere, 13th; Dyberry, 16th.

Solar Halos.—Eagles Mere, 1st, 15th, 18th, 27th; Dyberry, 15th.

Lunar Halos.—Hollidaysburg, 15th; Quakertown, 14th; Rimersburg, 14th, 15th; Clarion, 14th, 15th; Grampian Hills, 14th; Erie, 8th, 15th; McConnellsburg, 14th; Lancaster, 14th; Philadelphia, 10th, 14th; Girardville, 14th, 15th; Somerset, 14th, 15th; Eagles Mere, 15th; Dyberry, 14th.

Parhelia.—Dyberry, 19th.

Earthquake.—Coatesville, 8th; Lancaster, 8th; Selins Grove, 8th; York, 8th.

Monthly Summary of Reports by Voluntary Observers of the Pennsylvania State Weather S

County.	Station.	Elevation above Sea Level (feet).	Barometer.			Temperature.													Relative Humidity.	Dew Point.	P
							Maximum.		Minimum.				Daily Range.								
			Mean.	Highest.	Lowest.	Mean.	Highest.	Date.	Lowest.	Date.	Mean of Maximum.	Mean of Minimum.	Mean.	Greatest.	Date.	Least.	Date.				Total Inches.
Allegheny,[1]	Pittsburgh,	847	29·935	30·390	29·470	41·4	70·0	31	23·0	30	51·3	35·1	16·2	36·0	31	5·0	19	65·8	29·6	2·32
Beaver,	Rochester	821	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Bedford,	Charlesville,	1,300	. . .	. . .	. . .	39·2	67·5	31	19·5	12	50·4	28·8	21·6	41·0	13	4·5	18	77·3	28·4	4·16
Berks,[1]	Reading,	304	29·929	30·489	29·380	38·9	69·0	14	22·5	30	51·3	31·8	19·5	40·0	14	4·0	4	86·6	34·7	3·71
Blair,[2]	Altoona,	1,181	. . .	. . .	. . .	42·7	65·0	19	22·0	30	51·5	33·9	17·6	34·0	30	9·0	5	6 . 4	30·0	2·37
Blair,	Hollidaysburg,	947	. . .	. . .	. . .	39·0	68·0	17	18·0	30	50·0	28·0	22·0	43·0	17	7·0	10	84·0	36·0	3·69
Bradford,	Wysox,	718	. . .	. . .	. . .	36·2	62·7	24	21·0	30	44·2	29·0	15·2	38·0	24	3·5	5	79·8	30·0	1·73
Bucks,	Forks of Neshaminy,	. . .	. . .	. . .	. . .	40·4	60·0	24	24·0	30	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	3·35
Bucks,	Point Pleasant,	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Bucks,	Quakertown,	536	29·930	30·510	29·330	38·5	63·7	24	19·5	26	48·4	29·7	18·7	35·3	13	7·2	4	74·3	30·0	3·47
Butler,	Butler,	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Cambria,	Johnstown,	1,184	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Cameron,	Emporium,	1,030	. . .	. . .	. . .	40·0	65·0	18	11·0	30	49·6	26·6	23·0	38·0	16	9·0	4	68·0	30·0	1·44
Centre,	State College—Agricultural Experiment Station,	1,191	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Centre,	Phillipsburg,	1,350	. . .	. . .	. . .	32·8	67·0	18	13·0	30	44·4	27·0	17·0	40·0	17	5·0	10	. . .	. . .	2·27
Chester,	West Chester,	455	29·913	30·503	29·341	40·1	63·5	13, 27	22·0	30, 31	40·4	32·1	8·3	31·0	31	5·0	21	66·0	29·6	5·44
Chester,	Coatesville,	380	. . .	. . .	. . .	39·8	67·0	13	21·0	26	51·3	30·6	20·7	40·0	13	7·0	4	. . .	. . .	4·49
Chester,[1]	Westtown,	550	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Clarion,	Rimersburg,	1,500	. . .	. . .	. . .	38·0	70·0	18	12·0	11	46·0	30·0	16·0	34·0	26	4·0	4	. . .	. . .	. . .
Clarion,	Clarion—State Normal School,	1,530	. . .	. . .	. . .	37·7	67·0	17	9·0	30	46·8	28·7	18·1	36·5	26	5·0	4	80·0	31·0	1·91
Clearfield,	Grampian Hills,	1,450	. . .	. . .	. . .	36·6	66·0	18	12·0	30	45·4	30·0	15·4	32·0	26	2·0	5	. . .	. . .	2·57
Clinton,	Lock Haven,	560	. . .	. . .	. . .	39·2	69·0	17	19·0	26	49·0	28·0	21·0	43·0	17	6·0	10	. . .	. . .	2·63
Columbia,	Catawissa,	491	. . .	. . .	. . .	40·7	65·5	24	23·0	30	50·5	33·5	17·0	32·0	18	5·0	4	. . .	. . .	2·99
Crawford,	Meadville—Allegheny College,	1,050	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Cumberland,	Carlisle,	480	. . .	. . .	. . .	41·3	68·5	24	25·0	18, 30	51·1	34·4	16·7	36·5	26	2·0	19	71·0	31·8	1·91
Dauphin,[1]	Harrisburg,	361	29·959	30·540	29·400	40·0	62·0	13, 24	23·0	30	47·7	34·0	13·7	28·0	13	4·0	20	75·4	32·2	3·26
Delaware,	Swarthmore—Swarthmore College,	190	29·987	30·431	29·572	40·3	64·9	27	24·0	30	49·1	32·8	16·3	33·8	27	5·8	10	74·6	31·9	3·43
Erie,[1]	Erie,	681	29·980	30·450	29·470	34·0	58·0	27	20·0	11	40·0	27·0	11·0	24·0	15	3·0	8	78·0	27·0	1·73
Fayette,	Uniontown,	1,000	29·960	30·364	29·510	41·5	68·0	18	11·0	11, 30	50·7	29·7	21·0	36·0	17	7·0	5	72·0	. . .	3·60
Forest,	Tionesta,	1,058	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Fulton,	McConnellsburg,	875	. . .	. . .	. . .	40·0	66·0	24	22·0	30	51·9	31·1	20·8	37·0	13	5·0	21	75·7	31·2	4·76
Huntingdon,	Huntingdon—The Normal College,	650	. . .	. . .	. . .	38·9	65·0	18	19·0	25	47·5	29·0	18·5	44·0	18	2·0	10	. . .	. . .	3·17
Indiana,	Indiana—State Normal School,	1,390	. . .	. . .	. . .	43·2	69·0	18	17·0	11	50·8	31·9	18·9	33·0	26	6·0	21	76 5	37·8	1·47
Lackawanna,	Scranton,	750	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Lancaster,	Lancaster—Franklin and Marshall College,	413	29·925	30·511	29·340	40·4	64·0	24	21·0	26	46·5	31·8	17·7	32·0	13	5·5	3	61·5	28·7	3·89
Lawrence,	New Castle,	932	. . .	. . .	. . .	45·3	69·0	17	9·0	30	51·0	25·0	26·0	40·0	17	7·0	21	88·2	41·5	2·73
Lebanon,	Lebanon,	480	29·915	30·523	29·347	38·4	65·0	13	24·1	30	50·0	32·4	17·6	35·2	13	3·5	3	72·4	30·0	3·45
Luzerne,	Drifton—Drifton Hospital,	1,655	. . .	. . .	. . .	35·8	61·0	13, 27	15·0	30	47·8	28·8	19·0	33·0	14	8·0	4	. . .	. . .	2·61
McKean,	Smethport,	1,500	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Mercer,[1]	Greenville—Thiel College,	1,000	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Montgomery,	Pottstown,	150	. . .	. . .	. . .	43·0	68·0	13	24·0	30	50·6	34·6	16·0	36·0	13	4·0	19	71·7	34·5	3·73
Northampton,	Bethlehem,	360	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. .
Northumberland,	Shamokin,	733	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Perry,	New Bloomfield,	400	. . .	. . .	. . .	38·9	66·0	17	19·0	26	48·7	29·9	18·8	38·0	18	2·0	19	. . .	. . .	3·91
Philadelphia,[1]	Philadelphia,	117	29·941	30·530	29·360	41·1	66·0	27	25·0	30	49·4	35·1	14·3	31·0	27	5·0	20	67·4	30·6	2·58
Potter,	Coudersport,	1,670	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Schuylkill,	Girardville,	1,000	29·955	30·469	29·426	38·8	61·0	18	19·0	30	46·5	29·9	16·6	40·0	31	6·0	4	. . .	. . .	2·77
Snyder,	Selins Grove,	445	. . .	. . .	. . .	44·0	62·0	13	24·0	30	49·3	39·7	9·6	28·0	17	3·0	20	77·0	33·4	2·60
Somerset,	Somerset,	2,250	. . .	. . .	. . .	35·3	63·0	17, 31	9·0	30	47·2	21·0	26·2	36·0	17	3·0	5	89·4	29·1	2·52
Sullivan,	Eagles Mere,	2,000	30·011	30·539	29·386	33·4	56·0	24	10·0	30	41·3	25·5	14·8	25·0	25	3·0	21	64·6	22·3	1·85
Tioga,	Wellsboro,	1,327	29·923	30·466	29·307	35·7	63·0	17	18·0	30	45·6	28·9	16·7	36·4	30	5·2	5	80·6	26·3	3·24
Venango,	Franklin,	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Warren,	Columbus,	1,410	29·992	30·560	29·589	36·5	76·0	17	4·0	11	47·0	26·0	21·0	46·0	17	2·0	8	. . .	. . .	1·63
Wayne,	Dyberry,	1,100	. . .	. . .	. . .	33·3	59·0	24	11·0	12	42·7	25·9	16·8	35·0	24	4·0	4	. . .	. . .	1·74
Wayne,	Honesdale,	1,000	. . .	. . .	. . .	34·2	56·0	24	15·0	12	41·6	26·8	14·8	30·0	12	4·0	20	. . .	. . .	1·88
York,[1]	York,	385	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .

[1] Observations taken at 8 A. M. and 8 P. M. [2] Observations taken at 12 Noon.

Voluntary Observers of the Pennsylvania State Weather Service for Marc

Temperature.									Relative Humidity.	Dew Point.	Precipitation.			Numb
Minimum.		Mean of Maximum.	Mean of Minimum.	Daily Range.										
Lowest.	Date.			Mean.	Greatest.	Date.	Least.	Date.			Total Inches.	Total Snowfall During Month.	Number of Days Rainfall.	Clear.
23·0	30	51·3	35·1	16·2	36·0	31	5·0	19	65·8	29·6	2·32	. . .	15	6
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
19·5	12	50·4	28·8	21·6	41·0	13	4·5	18	77·1	28·4	4·16	11·50	7	. . .
22·5	30	51·3	31·8	19·5	40·0	14	4·0	4	86·6	34·7	3·71	3·50	9	11
22·0	30	51·5	33·9	17·6	34·0	30	9·0	5	6 . ·4	30·0	2·37	. . .	9	. . .
18·0	30	50·0	28·0	22·0	43·0	17	7·0	10	84·0	36·0	3·09	. . .	10	16
21·0	30	44·2	29·0	15·2	38·0	24	3·5	5	79·8	30·0	1·73	4·50	8	11
24·0	30	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	3·35	. . .	5	10
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
19·5	26	48·4	29·7	18·7	35·5	13	7·2	4	74·3	30·0	3·47	3·20	10	9
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
11·0	30	49·6	26·6	23·0	38·0	16	9·0	4	68·0	30·0	1·44	3·45	8	11
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
13·0	30	44·4	27·0	17·0	40·0	17	5·0	10	. . .	. . .	2·27	2·25	13	9
22·0	30, 31	40·4	32·1	8·3	31·0	31	5·0	21	66·0	29·6	5·44	3·00	15	11
21·0	26	51·3	30·6	20·7	40·0	13	7·0	4	. . .	. . .	4·49	2·96	14	9
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
12·0	11	46·0	30·0	16·0	34·0	26	4·0	4	. . .	. . .	. . .	6·0	. . .	9
9·0	30	46·8	28·7	18·1	36·5	26	5·0	4	80·0	31·0	1·91	. . .	4	10
12·0	30	45·4	30·0	15·4	32·0	26	2·0	5	. . .	. . .	2·57	7·00	12	12
19·0	26	49·0	28·0	21·0	43·0	17	6·0	10	. . .	. . .	2·63	3·50	8	11
23·0	30	50·5	33·5	17·0	32·0	18	5·0	4	. . .	. . .	2·99	3·50	7	10
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
25·0	18, 30	51·1	34·4	16·7	36·5	26	8·0	19	71·0	31·8	1·91	. . .	9	9
23·0	30	47·7	34·0	13·7	28·0	13	4·0	20	75·4	32·2	3·26	. .	9	7
24·0	30	49·1	32·8	16·3	33·8	27	5·8	19	74·6	31·9	3·43	. . .	10	4
20·0	11	40·0	29·0	11·0	24·0	15	3·0	8	78·0	27·0	1·73	4·00	10	11
11·0	11, 30	50·7	29·7	21·0	36·0	17	7·0	5	72·0	. . .	3·60	7·50	10	10
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
22·0	30	51·9	31·1	20·8	37·0	13	5·0	21	75·7	31·2	4·76	. . .	10	11
19·0	25	47·5	29·0	18·5	44·0	18	2·0	10	. . .	. . .	3·17	. . .	5	15
17·0	11	50·8	31·9	18·9	33·0	26	6·0	21	76·5	37·8	1·47	3·25	10	8
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. .
21·0	26	46·5	31·8	17·7	32·0	13	5·5	3	65·5	28·7	3·89	3·45	10	8
9·0	30	51·0	25·0	26·0	40·0	17	7·0	21	88·2	41·5	2·73	2·50	5	13
24·1	30	50·0	32·4	17·6	35·2	13	3·5	3	72·4	30·0	3·45	3·70	11	. . .
15·0	30	47·8	28·8	19·0	33·0	14	8·0	4	. . .	. . .	2·61	. . .	5	6
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
24·0	30	50·6	34·6	16·0	36·0	13	4·0	19	71·7	34·5	3·73	1·00	7	14
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
19·0	26	48·7	29·9	18·8	38·0	18	2·0	19	. . .	. . .	3·91	2·00	8	8
25·0	30	49·4	35·1	14·3	31·0	27	5·0	20	67·4	30·6	2·58	·50	12	11
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
19·0	30	46·5	29·9	16·6	40·0	31	6·0	4	. . .	. . .	2·77	8·00	8	16
24·0	30	49·3	39·7	9·6	28·0	17	3·0	20	77·0	33·4	2·60	2·50	5	12
9·0	30	47·2	21·0	26·2	36·0	17	3·0	5	89·4	29·1	2·52	7·80	14	11
10·0	30	40·3	23·5	14·8	25·0	25	3·0	21	64·6	22·3	1·85	9·60	6	8
18·0	30	45·6	28·9	16·7	36·4	30	5·2	5	80·6	26·3	3·24	3·00	8	10
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
4·0	11	47·0	26·0	21·0	46·0	17	2·0	8	. . .	. . .	1·83	. . .	9	10
11·0	12	42·7	25·9	16·8	35·0	24	4·0	4	. . .	. . .	1·74	5·50	7	6
15·0	12	41·6	26·8	14·8	30·0	12	4·0	20	. . .	. . .	1·88	. . .	10	. . .
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .

FOR MARCH, 1889.

H.	Number of Days.			Wind.			Observers.
Number of Days Rainfall.	Clear.	Fair.	Cloudy.	Prevailing Direction. 7 A. M.	2 P. M.	9 P. M.	
15	6	10	15	NW	NW	W	Oscar D. Stewart, Sgt. Sig. Corps.
...	...	...	...	...	...	...	Smith Curtis.
7	...	...	...	NW	NW	NW	Rev. A. Thos. G. Apple.
9	11	5	15	NW	NW	SW	C. M. Dechant, C.E.
9	...	...	...	...	...	...	Dr. Charles B. Dudley.
10	16	3	12	NW	W	W	Prof. J. A. Stewart.
8	11	3	17	NW	NW	NW	Charles Beecher.
5	10	7	14	NW	NW	NW	
...	...	...	...	...	...	...	
10	9	6	16	NE	NE	NE	J. L. Heacock.
...	...	...	...	...	...	...	J. E. Forsythe.
...	...	...	...	...	...	...	E. C. Lorentz.
8	11	8	12	W	W	W	T. B. Lloyd
...	...	...	...	...	...	...	Prof. Wm. Frear.
13	9	10	12	SW	SW	SW	Geo. H. Dunkle.
15	11	8	12	NW	NW	NW	Jesse C. Green, D.D.S.
14	9	9	13	W	W	W	W. T. Gordon.
...	...	...	...	...	...	...	
...	9	10	12	N	W	W	Rev. W. W. Deatrick, A.M.
4	10	8	13	SW	SW	SW	C. M. Thomas, B.S.
12	13	5	14	W	W	W	Nathan Moore.
8	11	6	14	W	W	W	Prof. John A. Robb.
7	10	9	12	N	N	N	Robert M. Graham.
...	...	...	...	...	...	...	R. B. Derickson.
9	9	8	14	N	W	SW	I. E. Pague.
9	7	9	15	NW	NW	NW	Frank Ridgway, Sgt. Sig. Corps.
10	4	10	17	NW	NW	NW	Prof. Susan J. Cunningham.
10	11	12	8	NE	NE	NE	Peter Wood, Sgt. Sig. Corps.
10	10	10	10	...	...	...	Wm. Hunt.
...	...	...	...	...	...	...	Robert L. Haslet.
10	11	9	11	NW	NW	W	Thomas F. Sloan.
5	15	3	13	W	W	W	Prof. W. J. Swigart.
10	8	11	12	W	W	W	Prof. Albert E Maltby.
...	...	...	...	...	...	...	J. F. Baumeister.
10	8	10	13	NW	W	NW	A. M. Schmidt, A.B.
5	13	4	15	NW	NW	NW	Wm. T. Butz.
11	...	...	...	NE	W	NW	George W. Hayes, C.E., Ph G.
5	6	14	11	...	...	...	H. D. Miller, M.D.
...	...	...	...	...	...	...	Armstrong & Brownell.
...	...	...	...	...	...	...	Prof. S. H. Miller.
7	14	6	11	NW	W	W	Charles Moore, D.D.S.
...	...	...	...	...	...	...	Lerch & Rice.
...	...	...	...	...	...	...	G. R. Hanley.
8	8	6	17	W	W	W	Frank Mortimer.
12	11	5	15	NW	NW	NW	Luther M. Dey, Sgt. Sig Corps.
...	...	...	...	...	...	...	C. L. Peck.
8	16	6	9	NE	NW	NW	E. C. Wagner.
5	12	8	11	NW	NW	NW	I. M. Boyer,
14	11	7	13	NW	NW	NW	W. M. Schrock.
6	8	9	14	SW	NE	NE	E. S. Chase.
8	10	7	14	N	N	N	H. D. Deming.
...	...	...	...	...	...	...	Prof. N. P. Kinsley.
9	10	9	12	NE	SW	SW	Wm. Loveland.
7	6	6	19	NW	NW	NW	Theodore Day.
10	...	...	...	...	...	...	John Torrey.
...	...	...	...	...	...	...	Mrs. L. H. Grenewald.

T. F. TOWNSEND, *Sergeant Signal Corps, Assistant.*

	Erie.
1	.04
2	.17
3	.36
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9	.06
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27	.00
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29	.10
30	.04
31	.04
	1.73

PRECIPITATION FOR MARCH, 1889.

	Erie.	New Castle.	Columbus.	Pittsburgh.	Uniontown.	Clarion.	Indiana.	Somerset.	Grampian Hills.	Emporium.	Phillipsburg.	Huntingdon.	Hollidaysburg.	Altoona.	McConnellsburg.	Lock Haven.	New Bloomfield.	Carlisle.	Wellsboro.	Harrisburg.	Selins Grove.	Wyncox.	Eagles Mere.	Catawissa.	Girardville.	Lebanon.	Lancaster.	Drifton.	Reading.	Pottstown.	West Chester.	Westtown	Coatesville.	Dyberry.	Honesdale.	Quakertown.	Swarthmore.	Philadelphia.	Schoholtzville.	Frederick.	Ottsville.	Smith's Corner.	Doylestown.	Lansdale.	Forks of Neisam'y.	Germantown.	Point Pleasant.
1	.04	. .	. .	.05	.05	. .	.02	.10	. .	.25	. .	. .	.18	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.12	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
2	.17	. .	.22	.34	.33	.75	.45	.20	.22	.04	.06	. .	.23	.02	.21	.60	.35	. .	.10	.06	.16	.17	.73	.03	.15	.05	.03	. .	. .	. .	.01	. .	.05	. .	.12	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
3	.38	.90	.38	.81	.60	.07	.20	.07	.45	.38	.53	.60	.68	.47	.53	.32	.50	. .	1.54	.66	.34	.30	. .	.50	.95	.71	.96	. .	.74	.75	1.02	. .	1.23	. .	.18	.47	.18	.54	. .	.26	. .	. .	. .	. .	. .	. .	. .
4	. .	. .	. .	.11	.70	. .	.10	.60	.73	.33	.72	1.31	1.06	.95	1.77	.73	2.20	. .	.60	2.13	1.22	.49	.28	1.64	.95	1.75	1.71	1.32	1.42	1.45	2.35	. .	1.60	.75	.57	1.25	1.59	.94	. .	1.31	2.08	. .	. .	. .	. .	. .	. .
5	. .	. .	. .	.01	.05	. .	.05	. .	. .	. .	.16	.14	. .	.08	.86	. .	. .	1.40	.20	.05	.63	. .	. .	. .	. .	.14	.29	.44	. .	.25	.34	. .	.23	. .	. .	.33	.23	.06	2.26	.12	. .	1.80	2.19	1.57	1.83	1.58	1.89
6	. .	. .	. .	.01	. .	. .	. .	.15	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
7	. .	. .	.02	. .	.03	. .	. .	. .	.03	. .	.01	. .	.30	. .	. .	. .	. .	. .	. .	. .	. .	.02	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.01	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
8	. .	. .	. .	.02	. .	. .	.03	. .	. .	. .	.02	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.01	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
9	.06	. .	.04	.01	.05	. .	. .	.05	.03	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.04	.19	. .	.03	.02	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
10	.20	.20	. .	.11	.05	. .	.10	.14	. .	. .	.05	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.02	. .	. .	. .	. .	.02	. .	.03	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
11	. .	. .	. .	.01	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
12	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
13	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
14	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
15	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
16	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.02	. .	.04	. .	. .	. .	. .	.01	. .	. .	. .	. .	. .	. .	. .	. .	. .
17	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.15	. .	.01	.27	.28	. .	. .	. .	.03	.36	.05	. .	. .	.05	.03	. .	.09
18	. .	. .	. .	. .	.31	. .	. .	.19	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.02	. .	. .	.01	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
19	. .	. .	. .	.16	.66	. .	.08	.29	.08	. .	.05	. .	.38	.14	.57	.05	.20	.01	. .	.07	. .	. .	. .	. .	. .	.07	. .	. .	. .	. .	.10	. .	.03	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
20	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.08	. .	.04	.10	. .	.04	. .	.18	.30	.20	.10	. .	.03	.25	.21	. .	.28	. .	.17	.05	.18	.11	.30	.16	. .	. .	. .	. .	. .	. .	.02	. .	. .
21	.02	.33	.05	.10	.15	.28	.10	.32	.15	.06	.20	.62	.36	.13	.48	.24	.25	.30	. .	.17	. .	.03	. .	.22	.40	.46	.54	.45	.62	.80	.64	. .	.66	.17	.03	.69	.55	.54	.78	.69	1.13	1.13	1.26	.85	1.39	1.46	1.40
22	. .	. .	. .	.02	. .	. .	.40	.06	.20	.07	.33	. .	.07	.14	.15	.21	.12	.02	. .	.03	. .	. .	. .	. .	. .	.03	. .	. .	.18	. .	.16	. .	.08	. .	. .	.13	.34	.13	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
23	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.40	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
24	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
25	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
26	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
27	.08	. .	.03	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.03	. .	. .	. .	.10	. .	. .	. .	. .	. .	. .	.08	.06	. .	.34	.20	. .	. .	. .	. .	.12	. .	. .	.32	.07	. .	.05	. .	.10	. .	. .	. .	. .
28	. .	. .	. .	.04	.40	. .	. .	.08	.03	. .	.01	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.03	. .	.04	. .	.11	. .	.12	. .	. .	.01	.04	.04	.04	.11	.27	.15	.11	.06	.08	.07	. .	. .
29	.10	.05	.15	.13	. .	. .	. .	.15	.05	.06	. .	. .	.13	.02	. .	.01	. .	. .	.05	. .	. .	.50	.13	.05	.01	. .	.02	. .	. .	.10	.06	. .	. .	.14	.01	. .	. .	.05	. .	. .	. .	.08	. .	.16	. .	. .	.02
30	.04	. .	.01	. .	.22	. .	. .	. .	. .	. .	.06	. .	. .	.02	.05	. .	.02	. .	. .	. .	. .	. .	. .	. .	. .	.05	. .	.02	. .	.06	. .	.10	. .	. .	.18	. .	.05	. .	.04	. .	.07	. .	.16	. .	.17	. .	. .
31	.64	1.25	.73	.39	. .	.81	. .	.12	.60	.25	.07	.50	.30	.42	.08	.47	.25	.08	.25	.04	.25	. .	.22	.35	.18	.17	.12	.15	.14	.18	.16	. .	.14	.35	.49	.18	.17	.05	.14	.11	.58	.10	.13	.19	. .	.06	.05
	1.73	2.73	1.63	2.32	3.60	1.91	1.47	2.52	2.57	1.44	2.27	3.17	3.69	2.37	4.76	2.63	3.91	1.91	3.24	3.26	2.60	1.73	1.85	2.99	2.77	3.45	3.89	2.61	3.71	3.73	5.44	. .	4.40	1.74	1.88	1.47	3.43	2.58	3.59	2.74	4.42	3.35	3.77	2.98	3.35	3.34	3.45

T. F. T.

WEATHER SIGNALS.

Displayman.	*Station.*
U. S. Signal Office,	Philadelphia.
Wanamaker & Brown,	"
Pennsylvania Railroad Company,	"
Continental Brewing Company,	"
Samuel Simpson,	"
B. T. Babbitt,	"
Western Meat Company,	"
Neptune Laundry,	"
Chester Oil Company,	Chester.
C. W. Burkhart,	Shoemakerville.
A. N. Lindenmuth,	Allentown.
C. B. Whitehead,	Bradford.
Capt. Geo. R. Guss,	West Chester.
Werner & Son,	Emporium.
C. E. Lenhart,	Latrobe.
Thomas F. Sloan,	McConnellsburg.
J. H. Fulmer,	Muncy.
W. T. Butz,	New Castle.
S. W. Morrison,	Oxford.
Capt. A. Goldsmith,	Quakertown.
J. L. Morrison,	Sharon.
Wm. A. Engel,	Shenandoah.
Wm. Schrock,	Somerset.
Postmaster,	Meadville.
Frank Ross,	Oil City.
Lerch & Rice,	Bethlehem.
John W. Aitken,	Carbondale.
Signal Office,	Erie.
J. R. Raynsford,	Montrose.
E. P. Wilbur & Co.,	South Bethlehem.
Agricultural Experiment Station,	State College.
Signal Office,	Pittsburgh.
E. H. Baker,	Williamsport.
New Era,	Lancaster.
State Normal School,	Clarion.
Clarion Collegiate Institute,	Rimersburg.
E. S. Chase,	Eagles Mere.
Thiel College,	Greenville.
D. G. Hurley,	Altoona.
Armstrong & Brownell,	Smethport.
J. E. Forsythe,	Butler.
James H. Fones,	Tionesta.
Wister, Hacker & Savage,	Germantown.
W. J. Thompson & Co.,	Clifton Heights.
Steward M. Dreher,	Stroudsburg.

Displayman.	*Station.*
State Normal School,	Millersville.
E. C. Wagner,	Girardville.
Hartford P. Brown,	Rochester.
L. H. Grenewald,	York.
J. E. Pague,	Carlisle.
C. L. Peck,	Coudersport.
H. D. Miller,	Drifton.
Smith Curtis,	Beaver.
M. Tannehill,	Confluence.
S. C. Burkholder,	Pollock.
Robt. M. Graham,	Catawissa.
Henry F. Bitner,	Millersville.
A. J. Edelman,	Pottstown.
A. M. Wildman,	Langhorn.
N. E. Graham,	East Brady.
B. F. Gilmore,	Chambersburg.
Frank M. Morrow,	Altoona.
A. Simon's Sons,	Lock Haven.
E. W. McArthurs,	Meadville.
J. K. M. McGovern,	Lock No. 4.
Raftsman's Journal,	Clearfield.

PENNSYLVANIA STATE WEATHER SERVICE.

MONTHLY WEATHER REVIEW

FOR APRIL, 1889.

Prepared under the Direction of the Committee on Meteorology of the FRANKLIN INSTITUTE.

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, April 30, 1889.

TEMPERATURE.

The average temperature of the state for April, 1889, was 48°·7, which is 2° 2 above that of April, 1888, 46°·5, which is about normal. Determined from the mean of the daily maximum and minimum temperature, it was 49°·7, which is one degree higher.

The warmest period of the month was during the 19th and 20th, when the following temperatures were noted: Carlisle, 88°; Hollidaysburg, 84°; Emporium, 84°; Grampian Hills, 84°; Uniontown, 84°, and New Castle, 84°. The lowest temperatures were Charlesville, 14°; Somerset, 14°, and Uniontown, 17°. These occurred on the 7th.

Stations reporting the highest monthly means for the state during April were Selins Grove, 52°·8; Swarthmore, 52°·4; Bethlehem, 52°·4; and Carlisle, 52°·3. The lowest were Eagles Mere, 42°·3; Greenville, 44°·1; Wellsboro, 44°·2; Erie, 45°·0; Somerset, 45°·2, and Honesdale, 45°·2.

BAROMETER.

The mean barometric pressure, 29·99, is very nearly normal. The highest occurred on the 7th and 23d, and the lowest, 29·3, on the 27th. The latter was attended by heavy rains.

PRECIPITATION.

The precipitation averaged 4·50 inches, with a decided irregularity in its distribution. The greatest totals in inches were Wellsboro, 8·15; Girardville, 7·23, and Coatesville, 7·08. Most of the precipitation for the month

occurred from the 24th to the 29th, inclusive. Only a few stations report snow in measurable quantities. The following are notable exceptions: Charlesville, 5·20 inches; Rimersburg, 9 inches; Grampian Hills, 5 inches; McConnellsburg, 12 inches; Somerset, 12·50 inches, and Columbus, 6 inches. These amounts fell on the 6th.

WIND AND WEATHER.

The prevailing direction of wind was from the west. No violent wind storm of a general character passed over the state. The latter part of the month was characterized by heavy rain storms. Numerous frosts occurred without seriously damaging vegetation.

At the end of the month, grain, grass, fruits and foliage, were more advanced than usual at this season. Notwithstanding the absence of snow during the winter months, grain was not materially injured by freezing out.

Average number.—Rainy days, 11; clear days, 11; fair days, 8; cloudy days, 11.

MISCELLANEOUS PHENOMENA.

Thunder Storms.—Charlesville, 20th; Reading, 12th, 20th; Hollidaysburg, 12th, 24th; Quakertown, 12th, 20th; Emporium, 12th, 24th; State College, 11th, 12th, 24th; Phillipsburg, 11th, 12th, 20th, 24th; West Chester, 20th, 28th; Coatesville, 2d, 20th, 28th; Rimersburg, 12th, 24th; Grampian Hills, 12th, 20th, 24th; Lock Haven, 12th, 24th; Catawissa, 12th; Carlisle, 13th, 20th; Harrisburg, 12th, 20th; Swarthmore, 12th, 20th, 28th; Uniontown, 12th, 24th; McConnellsburg, 12th; Huntingdon, 3d, 12th; Lancaster, 12th, 27th; New Castle, 12th; Bethlehem, 12th, 20th; New Bloomfield, 12th, 27th; Philadelphia, 12th, 20th; Girardville, 20th; Selins Grove, 12th; Somerset, 12th, 24th; Eagles Mere, 12th, 20th; Columbus, 19th, 24th; Dyberry, 12th, 20th; York, 20th.

Snow.—Charlesville, 6th; Hollidaysburg, 6th; Emporium, 6th; Phillipsburg, 3d, 6th; Rimersburg, 6th; Grampian Hills, 6th; Uniontown, 6th; McConnellsburg, 6th; New Castle, 5th; Greenville, 5th; Selins Grove, 5th; Somerset, 6th; Columbus, 6th; Dyberry, 4th; York, 6th.

Frost.—Charlesville, 7th, 8th, 9th, 14th, 23d; Reading, 5th, 14th; Hollidaysburg, 7th, 8th, 17th, 22d, 23d; Wysox, 1st, 2d, 3d, 5th, 6th, 7th, 8th, 9th, 11th, 13th, 14th, 15th, 16th, 17th, 18th, 22d, 23d; Quakertown, 5th, 11th, 14th, 15th, 23d; Emporium, 5th, 7th, 9th, 11th, 15th, 16th, 17th, 22d; Phillipsburg, 7th, 8th, 9th, 10th, 15th, 16th, 17th; Coatesville, 23d; Rimersburg, 5th, 10th, 22d; Grampian Hills, 22d, 23d; Lock Haven, 22d; Catawissa, 7th, 8th, 9th, 10th, 11th, 14th, 15th, 16th; Erie, 7th, 8th, 10th, 14th, 15th; Uniontown, 9th, 10th, 14th; McConnellsburg, 11th, 22d; Huntingdon, 7th, 8th, 9th, 11th, 14th, 16th, 22d, 23d; New Castle, 6th, 7th, 14th, 23d; Greenville, 22d, 23d; New Bloomfield, 23d; Philadelphia, 15th, 23d; Selins Grove, 7th, 8th, 9th, 10th, 11th, 14th, 15th, 16th, 22d, 23d; Somerset, 22d, 23d; Wellsboro, 14th; Columbus, 1st, 2d, 4th, 5th, 6th, 7th, 8th, 10th, 11th, 13th, 14th, 15th, 16th, 17th, 21st, 22d, 23d; Dyberry, 2d, 3d, 4th, 5th, 6th, 7th, 8th, 9th, 10th, 11th, 13th, 14th, 15th, 16th, 17th, 22d, 23d; York, 5th, 11th, 15th, 23d.

Monthly Summary of Reports by Voluntary Observers of the Pennsylvania State Weather Se

County.	Station.	Elevation above Sea Level (feet).	Barometer.			Temperature.							Daily Range.					Relative Humidity.	Dew Point.	Prec
							Maximum.		Minimum.											
			Mean.	Highest.	Lowest.	Mean.	Highest.	Date.	Lowest.	Date.	Mean of Maximum.	Mean of Minimum.	Mean.	Greatest.	Date.	Least.	Date.			Total Inches
Allegheny,[1]	Pittsburgh,	847	29·985	30·480	29·450	50·8	83·0	19	25·0	6	61·2	43·5	17·7	38·0	23	3·0	28	63·5	37·8	3·62
Beaver,	Rochester	821	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Bedford,	Charlesville,	1,300	. . .	. . .	. . .	49·5	79·5	19	14·0	7	61·3	40·5	20·8	39·5	23	3·5	27	69·2	38·6	4·76
Berks,[1]	Reading,	304	30·001	30·408	29·336	49·4	78·0	19	27·0	14	62·7	40·8	21·9	43·0	11	6·0	26	80·0	42·2	6·33
Blair,[2]	Altoona,	1,181	. . .	. . .	. . .	54·3	82·0	20	47·0	7	69·5	42·2	20·3	35·0	22	8·0	29	58·2	40·0	3·44
Blair,	Hollidaysburg,	947	. . .	. . .	. . .	51·0	84·0	19	25·0	23	63·0	36·0	27·0	47·0	11	8·0	27, 28	83·0	45·0	4·07
Bradford,	Wysox,	718	. . .	. . .	. . .	47·0	81·0	19	22·0	23	57·9	36·4	21·5	41·0	23	5·0	4	75·9	40·0	3·78
Bucks,	Forks of Neshaminy,	. . .	. . .	. . .	. . .	50·5	80·0	19	34·0	14	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	4·68
Bucks,	Point Pleasant,	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Bucks,	Quakertown,	536	30·029	30·490	29·380	49·7	79·0	20	24·0	6	61·3	38·6	22·7	43·8	11	6·3	27	74·0	40·6	4·83
Butler,	Butler,	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Cambria,	Johnstown,	1,184	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Cameron,	Emporium,	1,030	. . .	. . .	. . .	51·6	84·0	19	21·0	8	62·1	34·0	28·1	47·0	23	11·0	30	65·4	39·2	3·66
Centre,	State College—Agricultural Experiment Station,	1,191	29·988	30·493	29·335	49·0	81·0	19	25·0	14	58·2	40·7	17·5	37·0	11	7·0	26	83·3	41·5	3·65
Centre,	Phillipsburg,	1,350	. . .	. . .	. . .	45·8	81·0	19	22·0	7	60·0	34·9	25·1	42·0	17	8·0	28	. . .	. . .	6·09
Chester,	West Chester,	455	29·970	30·467	29·238	51·2	77·0	20, 21	30·0	14	61·1	42·2	18·9	32·5	11	4·0	27	67·0	40·0	5·46
Chester,	Coatesville,	380	. . .	. . .	. . .	49·6	83·0	20	27·0	14	61·8	39·2	22·6	45·0	11	5·0	27	. . .	. . .	7·08
Chester,[1]	Westtown,	550	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Clarion,	Rimersburg,	1,500	. . .	. . .	. . .	47·7	82·0	19	23·0	6	57·9	38·8	19·1	36·0	16	2·0	28	. . .	. . .	. . .
Clarion,	Clarion—State Normal School,	1,530	. . .	. . .	. . .	47·2	79·5	19	21·0	14	58·5	33·9	14·6	46·0	23	6·0	28	73·7	39·2	2·09
Clearfield,	Grampian Hills,	1,450	. . .	. . .	. . .	47·8	84·0	19	26·0	5	58·0	43·3	14·7	40·0	23	2·0	28	. . .	. . .	4·61
Clinton,	Lock Haven,	560	. . .	. . .	. . .	50·5	85·0	19	26·0	14	60·2	37·0	23·2	41·0	19	4·0	26	. . .	. . .	3·97
Columbia,	Catawissa,	491	. . .	. . .	. . .	51·3	82·0	20	29·0	7, 8	63·0	41·7	21·3	37·0	11	5·0	25	75·0	43·2	4·42
Crawford,	Meadville—Allegheny College,	1,050	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Cumberland,	Carlisle,	480	. . .	. . .	. . .	52·3	88·0	20	35·0	7	63·0	45·9	17·1	35·0	21	3·0	25	71·0	43·7	4·56
Dauphin,[1]	Harrisburg,	361	29·613	30·470	29·000	50·6	80·0	20	34·0	5, 14	60·2	43·3	16·9	31·0	11	5·0	25	74·3	42·0	3·96
Delaware,	Swarthmore—Swarthmore College,	190	. . .	. . .	. . .	52·4	77·0	21	29·8	5	63·5	43·1	20·4	38·1	11	6·8	26	74·9	43·7	3·51
Erie,[1]	Erie,	681	30·010	30·540	29·410	45·0	83·0	19	28·0	6	52·0	38·0	14·0	36·0	23	3·0	1	74·0	36·0	3·64
Fayette,	Uniontown,	1,000	29·984	30·354	29·435	50·8	84·0	20	17·0	7	61·6	38·4	23·2	40·0	24	2·0	16	. . .	. . .	4·47
Forest,	Tionesta,	1,058	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Fulton,	McConnellsburg,	875	. . .	. . .	. . .	51·5	82·0	20	25·0	7	63·7	40·9	22·8	38·0	11	7·0	27	68·1	40·7	5·28
Huntingdon,	Huntingdon—The Normal College,	650	. . .	. . .	. . .	50·0	81·0	19	26·0	23, 24	60·9	39·4	21·5	48·0	11	5·0	26, 28	. . .	. . .	4·42
Indiana,	Indiana—State Normal School,	1,350	. . .	. . .	. . .	62·1	82·0	6	38·0	2, 25	65·5	57·5	8·0	16·0	23	3·0	11	88·1	58·4	4·50
Lackawanna,	Scranton,	750	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Lancaster,	Lancaster—Franklin and Marshall College,	413	29·967	30·447	29·259	51·7	81·5	20	28·0	14	61·8	40·8	21·0	40·5	11	6·5	5	70·2	41·6	6·54
Lawrence,	New Castle,	932	. . .	. . .	. . .	50·1	84·0	19	21·0	6	60·0	35·0	25·0	46·0	23	7·0	4, 28	87·4	47·1	6·06
Lebanon,	Myerstown,	474	29·917	30·415	29·225	50·0	82·0	20	27·6	5	63·0	41·1	21·9	33·7	19	6·2	26	79·4	43·7	5·47
Luzerne,	Drifton—Drifton Hospital,	1,653	. . .	. . .	. . .	47·1	76·0	21	11·0	28	60·9	37·6	23·3	32·0	16	11·0	28	. . .	. . .	5·89
McKean,	Smethport,	1,500	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Mercer,[1]	Greenville—Thiel College,	1,000	29·932	30·468	29·362	44·1	82·0	19	23·3	6	58·4	35·2	23·2	43·7	23	4·0	28	79·9	37·8	2·50
Montgomery,	Pottstown,	150	. . .	. . .	. . .	51·0	79·0	19	32·0	14	62·0	44·0	18·0	43·0	11	2·0	26	68·0	41·0	6·15
Northampton,	Bethlehem,	360	. . .	. . .	. . .	52·4	82·0	20	28·0	3	62·7	42·2	20·5	39·0	11	6·0	26	65·5	40·0	4·29
Northumberland,	Shamokin,	733	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Perry,	New Bloomfield,	400	. . .	. . .	. . .	50·1	83·0	20	27·0	16	62·3	37·0	23·3	42·0	11	7·0	28	. . .	. . .	3·88
Philadelphia,[1]	Philadelphia,	117	29·984	30·490	29·270	51·6	78·0	21	34·0	14	61·6	44·8	16·8	29·0	11	5·0	27	68·2	40·6	3·17
Potter,	Coudersport,	1,670	. . .	. . .	. . .	47·1	78·0	19	19·0	6, 22	58·0	30·0	28·0	48·0	18	3·0	29	67·3	38·5	4·50
Schuylkill,	Girardville,	1,000	29·980	30·388	29·354	49·8	78·0	20	23·0	8	59·1	38·5	20·6	37·0	8, 11	6·0	25, 27	. . .	. . .	7·23
Snyder,	Seins Grove,	445	. . .	. . .	. . .	52·8	80·0	20	32·0	3	60·0	44·8	15·2	33·0	11	6·0	25	72·4	43·2	3·00
Somerset,	Somerset,	2,250	. . .	. . .	. . .	45·2	72·0	24	14·0	7	63·2	27·2	36·0	38·0	12	5·0	27	89·0	42·0	4·55
Sullivan,	Eagles Mere,	2,000	29·989	30·507	29·356	42·3	74·0	20	24·0	14	52·7	31·9	17·8	32·0	3, 18	2·0	1	69·8	33·6	5·71
Tioga,	Wellsboro,	1,327	29·560	30·374	29·316	44·2	80·0	19	22·0	23	55·9	35·1	20·8	34·4	19	6·0	29	76·1	32·6	8·15
Venango,	Franklin,	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Warren,	Columbus,	1,410	. . .	. . .	. . .	45·5	82·0	19	20·0	14	58·3	32·7	25·6	52·0	23	4·0	30	. . .	. . .	3·24
Wayne,	Dyberry,	1,100	. . .	. . .	. . .	45·8	79·0	20	19·0	23	57·0	34·3	22·7	44·0	11	3·0	27	. . .	. . .	4·55
Wayne,	Honesdale,	1,000	. . .	. . .	. . .	45·2	77·0	20	22·0	23	55·1	35·3	19·8	40·0	11	4·0	28	. . .	. . .	5·55
York,[1]	York,	385	30·020	30·371	29·371	50·2	82·0	20	31·5	14	63·1	41·3	21·8	40·0	11	5·0	13	72·4	41·9	3·91

[1] Observations taken at 8 A. M. and 8 P. M. [2] Observations taken at 12 Noon.

...TS BY VOLUNTARY OBSERVERS OF THE PENNSYLVANIA STATE WEATHER SERVICE ...

...4.	Temperature.										Relative Humidity.	Dew Point.	Precipitation.		
	Minimum.		Mean of Maximum.	Mean of Minimum.	Daily Range.										
Date.	Lowest.	Date.			Mean.	Greatest.	Date.	Least.	Date.				Total Inches.	Total Snowfall During Month.	Number of ...
19	25·0	6	61·2	43·5	17·7	38·0	23	3·0	28		63·5	37·8	3·62	. . .	
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .		. . .	. . .	. . .	. . .	
19	14·0	7	61·3	40·5	20·8	39·5	23	3·5	27		69·2	36·6	4·76	5·20	
29	27·0	14	62·7	40·8	21·9	43·0	11	6·0	26		80·0	42·2	6·33	. . .	
20	47·0	7	69·5	42·2	20·3	35·0	22	8·0	29		58·2	40·0	3·44	. . .	
19	25·0	23	63·0	36·0	27·0	47·0	11	8·0	27, 28		83·0	45·0	4·07	. . .	
19	22·0	23	57·9	36·4	21·5	41·0	23	3·0	4		75·9	40·0	3·78	. . .	
19	34·0	14	. . .	. . .	. . .	. . .	. . .	. . .	. . .		. . .	. . .	4·68	. . .	
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .		. . .	. . .	. . .	. . .	
20	24·0	6	61·3	38·6	22·7	43·8	11	6·3	27		74·0	40·6	4·83	. . .	
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .		. . .	. . .	. . .	. . .	
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .		. . .	. . .	. . .	. . .	
19	21·0	8	62·1	34·0	28·1	47·0	23	11·0	30		65·4	39·2	3·66	. . .	
19	25·0	14	58·2	40·7	17·5	37·0	11	7·0	26		83·3	41·5	3·65	. . .	
19	22·0	7	60·0	34·9	25·1	42·0	17	8·0	28		. . .	. . .	6·09	. . .	
, 21	30·0	14	61·1	42·2	18·9	32·5	11	4·0	27		67·0	40·0	5·46	. . .	
20	27·0	14	61·8	39·2	22·6	45·0	11	5·0	27		. . .	. . .	7·08	. . .	
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .		. . .	. . .	. . .	. . .	
19	23·0	6	57·9	38·8	19·1	36·0	16	2·0	28		. . .	. . .	. . .	9·00	
19	21·0	14	58·5	33·9	14·6	46·0	23	6·0	28		73·7	39·2	2·09	. . .	
19	26·0	5	58·0	43·3	14·7	40·0	23	2·0	28		. . .	. . .	4·61	5·00	
19	26·0	14	60·2	37·0	23·2	41·0	19	4·0	26		. . .	. . .	3·97	. . .	
20	29·0	7, 8	63·0	41·7	21·3	37·0	11	5·0	25		75·0	43·2	4·42	. . .	
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .		. . .	. . .	. . .	. . .	
20	35·0	7	63·0	45·9	17·1	35·0	21	3·0	25		71·0	43·7	4·56	. . .	
20	34·0	5, 14	60·2	41·3	16·9	31·0	11	5·0	25		74·3	42·0	3·66	. . .	
21	29·8	5	63·5	43·1	20·4	38·1	11	6·8	26		74·9	43·7	3·51	. . .	
19	28·0	6	52·0	38·0	14·0	36·0	23	3·0	1		74·0	36·0	3·04	. . .	
20	17·0	7	61·6	38·4	23·2	40·0	24	8·0	16		. . .	. . .	4·47	. . .	
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .		. . .	. . .	. . .	. . .	
20	25·0	7	63·7	40·9	22·8	38·0	11	7·0	27		68·1	40·7	5·28	12·00	
19	26·0	23, 24	60·9	39·4	21·5	48·0	11	5·0	26, 28		. . .	. . .	4·42	. . .	
6	38·0	2, 25	65·3	37·5	8·0	16·0	23	3·0	11		88·1	58·4	4·50	. . .	
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .		. . .	. . .	. . .	. . .	
20	28·0	14	61·8	40·8	21·0	40·5	11	6·5	5		70·2	41·6	6·54	. . .	
19	21·0	6	60·0	35·0	25·0	46·0	23	7·0	1, 28		87·4	47·1	6·26	. . .	
20	27·6	5	63·0	41·2	21·9	33·7	19	6·2	26		79·4	43·7	5·47	. . .	
21	11·0	28	60·9	37·6	23·3	32·0	16	11·0	28		. . .	. . .	5·89	. . .	
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .		. . .	. . .	. . .	. . .	
19	23·3	6	58·4	35·2	23·2	45·7	23	4·0	28		70·9	37·8	2·50	3·00	
19	32·0	14	62·0	44·0	18·0	43·0	11	2·0	26		68·0	41·0	6·15	. . .	
20	28·0	5	62·7	42·2	20·5	39·0	11	6·0	26		65·5	40·0	4·29	. . .	
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .		. . .	. . .	. . .	. . .	
20	27·0	16	62·3	37·0	25·3	42·0	11	7·0	28		. . .	. . .	3·88	. . .	
21	34·0	14	61·6	44·8	16·8	29·0	11	5·0	27		68·2	40·6	3·17	. . .	
19	19·0	6, 22	58·0	36·0	28·0	48·0	18	3·0	29		67·3	38·5	4·30	. . .	
20	23·0	8	59·1	38·5	20·6	37·0	8, 11	6·0	25, 27		. . .	. . .	7·23	. . .	
20	32·0	5	60·0	41·8	15·2	33·0	11	6·0	25		72·4	43·2	3·09	. . .	
24	14·0	7	63·2	27·2	36·0	38·0	12	5·0	27		89·0	42·0	4·55	12·50	
20	24·0	14	52·7	31·9	17·8	32·0	9, 18	2·0	1		69·8	33·6	5·71	. . .	
19	22·0	23	55·9	33·1	20·8	34·4	19	6·0	29		76·1	32·6	8·15	. . .	
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .		. . .	. . .	. . .	. . .	
19	20·0	14	58·3	32·7	25·6	52·0	23	4·0	30		. . .	. . .	3·24	6·00	
20	19·0	23	57·0	34·3	22·7	44·0	11	3·0	27		. . .	. . .	4·55	. . .	
20	22·0	23	55·1	35·3	19·8	40·0	11	4·0	28		. . .	. . .	5·55	. . .	
20	31·5	14	63·1	41·3	21·8	40·0	11	5·0	13		72·4	41·9	3·91	. . .	

Service for April, 1889.

Precipitation.			Number of Days.			Wind.			Observers.
	Total Snowfall During Month.	Number of Days Rainfall.	Clear.	Fair.	Cloudy.	Prevailing Direction. 7 A. M.	2 P. M.	9 P. M.	
32	. . .	13	6	12	12	NW	NW	NW	Oscar D. Stewart, Sgt. Sig. Corps.
.	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	Smith Curtis.
76	5'20	12	9	11	10	W	W	W	Rev. A. Thos. G. Apple.
13	. . .	13	12	6	12	NW	NW	SW	C. M. Dechant, C.E.
14	. . .	12	. . .	. . .	. . .	. . .	. . .	. . .	Dr. Charles B. Dudley.
27	. . .	12	14	8	8	W	W	W	Prof. J. A. Stewart.
28	. . .	11	9	4	17	NW	NW	NW	Charles Beecher.
38	. . .	6	14	8	8	W	W	W	J. C. Hilsman.
.	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	
33	. . .	14	8	11	11	NE	NE	N	J. L. Heacock.
.	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	J. E. Forsythe.
.	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	E. C. Lorentz.
56	. . .	10	12	7	11	W	W	W	T. B. Lloyd
38	. . .	13	8	8	14	W	E	E	Prof. Wm. Frear.
29	. . .	15	11	7	12	SW	SW	SW	Geo. H. Dunkle.
36	. . .	15	11	9	10	NE	NE	NW	Jesse C. Green, D.D.S.
58	. . .	16	9	8	13	NE	W	W	W. T. Gordon.
.	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	
.	9'00	. . .	12	6	12	NW	W	W	Rev. W. W. Deatrick, A.M.
29	. . .	. . .	10	8	12	SW	SW	SW	C. M. Thomas, B.S.
31	5'00	14	13	6	11	SW	SW	SW	Nathan Moore.
27	. . .	12	14	5	11	E	W	W	Prof. John A. Robb.
32	. . .	10	12	8	10	NE	N	N	Robert M. Graham.
.	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	R. B. Derickson.
56	. . .	14	11	7	12	W	W	W	J. E. Pague.
36	. . .	13	6	12	12	N	N	N	Frank Ridgway, Sgt. Sig. Corps.
31	. . .	8	. . .	. . .	. . .	NW	NW	NE	Prof. Susan J. Cunningham.
34	. . .	14	9	10	11	W	W	W	Peter Wood, Sgt Sig. Corps.
47	. . .	10	14	3	11	SW	SW	W	Wm Hunt.
.	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	Robert L. Haslet.
28	12'00	11	11	9	10	N	W	W	Thomas F. Sloan.
32	. . .	13	8	14	8	W	W	W	Prof. W. J. Swigart.
30	. . .	6	14	6	10	W	W	W	Prof. Albert E. Maltby.
.	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	J. F. Baumeister.
34	. . .	12	8	8	14	NE	W	W	A. M. Schmidt, A.B.
56	. . .	8	11	5	14	NW	NW	NW	Wm. T. Butz.
47	. . .	13	11	8	11	W	W	W	Wm. H. Kline.
89	. . .	9	10	8	12	. . .	. . .	. . .	H. D. Miller, M.D.
.	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	Armstrong & Brownell.
50	3'00	9	10	9	11	SE	NE	NW	Prof. S. H. Miller.
15	. . .	9	12	11	7	E	W	W	Charles Moore, D.D.S.
59	. . .	8	14	6	10	W	W	W	Lerch & Rice.
.	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	G. R. Hanley.
38	. . .	12	11	7	12	N	N	W	Frank Mortimer.
47	. . .	14	6	8	16	NE	NE	NE	Luther M. Dey, Sgt. Sig Corps.
30	. . .	. . .	13	4	13	W	NW	NW	C. L. Peck.
23	. . .	11	14	6	10	NW	NW	NW	E. C. Wagner.
20	. . .	9	8	11	11	NE	NE	NW	J. M. Boyer,
55	12'50	10	11	7	12	NW	NW	NW	W. M. Schrock.
71	. . .	8	12	6	12	NE	NE	NE	E. S. Chase.
15	. . .	12	11	6	13	N	N	N	H. D. Deming.
.	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	Prof. N. P. Kinsley.
24	6'00	12	11	7	12	W	W	W	Wm. Loveland.
55	. . .	8	11	6	13	NW	NW	NW	Theodore Day.
55	. . .	10	. . .	. . .	. . .	. . .	. . .	. . .	John Torrey.
91	. . .	13	17	6	7	NW	NW	NW	Mrs. L. H. Grenewald.

T. F. Townsend, *Sergeant Signal Corps, Assistant.*

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PRECIPITATION FOR APRIL, 1889.

	Erie.	New Castle.	Greenville.	Columbus.	Pittsburgh.	Uniontown.	Clarion.	Indiana.	Somerset.	Grampian Hills.	Emporium.	Phillipsburg.	Huntingdon.	Hollidaysburg.	Altoona.	Charlesville.	McConnellsburg.	Lock Haven.	State College.	York.	New Bloomfield.	Carlisle.	Wellsboro.	Harrisburg.	Selins Grove.	Wyssox.	Eagles Mere.	Catawissa.	Girardville.	Lebanon.	Lancaster.	Drifton.	Reading.	Pottstown.	West Chester.
1	.28	.38	.34	.33	.36	.35	.40	. .	.48	.35	.50	.65	.10	.30	.12	.45	.53	.32	.20	.10	.48	.40	.72	.59	.22	.27	.75	.44	.51	. .	.75	. .	.47	.93	*
2	.19	. .	. .	.18	. .	. .	.05	. .	. .	.11	.07	.07	.12	. .	.10	. .	. .	.01	.17	.07	.06	.70	.08	.05	.18	.50	. .	.02	.18	. .	.12	. .	.07	.06	*
3	.01	. .	.12	.06	.17	. .	.14	. .	.20	.10	.05	.15	. .	.14	.06	.17	.16	.15	.04	.10	.10	.20	.03	.18	. .	.14	.	.08	.08	. .	.12	. .	.03	. .	*
4	.04	. .	. .	.03	.02	. .	. .	. .	. .	. .	. .	.05	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.
5	.02	. .	. .	. .	.02	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.
6	.48	1.75	.34	.65	.70	.09	.09	. .	.85	.64	.19	.74	. .	.99	.67	1.33	1.60	. .	.12	.05	. .	.36	. .	. .	. .	. .	. .	. .	. .	. .	.12	. .	. .	. .	.
7	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.
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9	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.
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11	.10	. .	. .	.17	.02	.04	. .	. .	. .	. .	. .	. .	.06	.23	. .	.02	. .	.01	.06	.01	.10	. .	.04	.01	.10	.12	.42	.24	.13	. .	.03	. .	.01	.05	*
12	.42	1.05	.37	.29	.77	.06	.25	. .	.65	.60	.22	.55	.18	.54	.20	.54	.70	.20	.37	. .	.40	.05	.24	.02	.10	.37	1.04	.85	.86	. .	. .	. .	.13	.30	.
13	. .	. .	.07	. .	.25	.85	.35	. .	.28	.95	. .	.74	1.65	.16	.75	.20	. .	.54	.60	. .	.30	.70	. .	.58	.81	. .	. .	. .	.15	. .	.32	. .	.45	. .	*
14	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.
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16	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.01	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	*
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20	.02	. .	. .	.01	. .	. .	. .	1.80	. .	.06	. .	. .	. .	. .	. .	. .	. .	. .	. .	.05	. .	. .	.10	.10	. .	. .	. .	. .	. .	.32	. .	.33	.25	*
21	. .	.78	. .	. .	. .	. .	. .	.24	. .	. .	. .	.13	. .	. .	. .	. .	. .	. .	. .	. .	. .	.50	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	*
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24	.46	1.27	.49	.31	.64	.72	. .	. .	.47	.10	1.00	.19	.04	.24	.20	. .	.22	. .	.10	. .	.75	.03	.10	. .	. .	.02	. .	. .	. .	. .	. .	. .	. .	. .	.
25	.02	. .	. .	. .	.18	.40	. .	. .	.22	.85	26	1.15	.90	.62	.70	.97	.61	.94	.63	.70	.70	.46	.56	1.04	.10	.46	. .	.80	1.47	. .	1.97	. .	2.25	1.60	*
26	. .	. .	. .	. .	. .	.23	. .	. .	.95	. .	. .	.23	.95	.41	.07	.91	.86	.25	.12	1.40	.35	.42	.04	.34	.25	.35	. .	.67	1.20	. .	1.73	. .	1.45	1.60	2.2
27	.45	. .	.51	.35	.35	.59	.33	. .	.22	.32	.39	.67	.18	.35	.45	.13	.32	.45	.46	1.30	.45	.26	1.86	.62	.66	.64	. .	.70	.98	. .	.73	. .	.64	.90	*
28	1.12	. .	.19	.70	.12	.24	. .	.02	.22	.38	.86	.38	.15	.07	.07	.02	.19	.65	.63	.05	.16	.31	3.36	.28	.30	.70	. .	.60	.93	. .	.29	. .	.36	.44	*
29	.03	.83	.07	.16	.02	. .	.48	2.00	. .	.15	.12	.40	.09	.04	.05	.01	.05	.43	.05	.01	.03	.14	.10	.14	.30	.21	3.50	.02	.73	. .	. .	. .	.08	. .	*
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	3.64	6.06	2.50	3.24	3.62	4.47	2.09	4.50	4.54	4.61	3.66	6.09	4.42	4.07	3.44	4.76	5.28	3.97	3.63	3.91	3.88	4.56	8.15	3.96	3.02	3.73	5.71	4.42	7.23	. .	6.54	.	6.33	6.15	5.4

PRECIPITATION FOR APRIL, 1889.

Carlisle.	Wellsboro.	Harrisburg.	Selins Grove.	Wyeox.	Eagles Mere.	Catawissa.	Girardville.	Lebanon.	Lancaster.	Drifton.	Reading.	Pottstown.	West Chester.	Westtown.	Coatesville.	Dyberry.	Coudersport.	Honesdale.	Quakertown.	Swarthmore.	Philadelphia.	Scisholtzville.	Frederick.	Ottsville.
.40	.72	.59	.22	.27	.75	.44	.51	. .	.75	. .	.47	.95	.31		.43	.36	.42	.18	.91	.43	.42	. .	.76	.8
.70	.08	.05	.18	.50	. .	.02	.18	. .	.12	. .	.09	.06	.22	. .	.22	.05	.10	.13	.10	.29	.21	.61	.09	. .
.20	.03	.18	. .	.14	. .	.08	.08	. .	.12	. .	.03	. .	.13	. .	.07	. .	. .	.11	. .	. .	.03	. .	.03	. .
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.05	.24	.02	.10	.37	1.04	.85	.86	. .	. .	. .	.13	.30	. .	. .	.01	.39	.30	.32	.14	. .	.02	.19	. .	. .
.70	. .	.58	.81	. .	. .	. .	.16	. .	.32	. .	.45	. .	.13	. .	.27	. .	.40	. .	.19	.07	.08	.61	.26	. .
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. .	.10	.10	. .	. .	. .	. .	. .	. .	.32	. .	.33	.25	.07	. .	.15	. .	. .	.24	.05	. .	. .	.04	. .	. .
.50	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	.04	. .	. .	. .	. .	. .	.02	.17	.20	. .	.17	. .
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.46	.56	1.04	.10	.46	. .	.80	1.47	. .	1.97	. .	2.25	1.60	.35	. .	1.02	. .	1.30	2.90	.25	. .	. .	. .	. .	. .
.42	.94	.34	.25	.35	. .	.67	1.20	. .	1.73	. .	1.45	1.60	2.88	. .	2.89	2.00	. .	.46	1.83	1.73	1.53	. .	. .	. .
.26	1.86	.62	.66	.64	. .	.70	.98	. .	.73	. .	.64	.90	.81	. .	.69	1.45	.30	.64	1.01	.42	.44	. .	2.19	. .
.31	3.36	.28	.30	.70	. .	.60	.93	. .	.29	. .	.36	.44	.35	. .	.31	. .	1.10	.48	.22	.39	.17	4.70	.21	3.04
.14	.10	.14	.30	.21	3.50	.02	.73	. .	. .	. .	.08	. .	.04	. .	. .	.30	.60	.09	.01	. .	.02	.01	.03	. .
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4.56	8.15	3.96	3.02	3.73	5.71	4.42	7.23	. .	6.54	.	6.33	6.15	5.46	. .	7.03	4 55	4.50	5.55	4.83	3.51	3.17	6.22	3.86	4.64

Philadelphia.	Schoharie.	Frederick.	Ottsville.	Smith's Corner.	Doylestown.	Lansdale.	Forks of Neshamy.	Germantown.	Point Pleasant.	Bethlehem.
·42	. .	·76	·83	·70	·73	·45	·67	. .	·94	·50
·21	·61	·09	. .	·06	·03	. .	·06	. .	. .	·05
·03	. .	·03	. .	. .	. .	·33	. .	·69	. .	. .
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·02	·19	. .	. .	·09	·22	·22	. .	. .	. .	·63
·08	·61	·26	. .	·22	. .	. .	·18	·17	·27	. .
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. .	·04	. .	·63	·25	·38	·30	. .	. .	·25	·05
·20	. .	·17	. .	. .	. .	. .	·27	·14	. .	. .
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·53	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
·44	. .	2·19	. .	. .	. .	. .	. .	. .	. .	. .
·17	4·70	·21	3·04	3·51	3·46	2·40	3·43	2·15	3·52	2·12
·08	·01	·03	. .	. .	·01	·35	. .	. .	. .	. .
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1·17	6·22	3·86	4·64	5·02	4·92	4·90	4·68	3·90	5·11	4·89

T. F. T.

Coronæ.—Huntingdon, 14th, 19th.

Solar Halos.—Charlesville, 9th, 11th, 15th, 19th, 30th; Eagles Mere, 11th, 22d.

Lunar Halos.—Charlesville, 9th, 14th; West Chester, 9th; Rimersburg, 14th; Greenville, 14th.

Parhelia.—Charlesville, 19th; Dyberry, 6th; Eagles Mere, 10th.

Auroras.—Rimersburg, 7th; Greenville, 9th; Eagles Mere, 7th.

Observers are particularly requested to measure and record the rainfall *each day*, instead of giving the total for each storm. Each day's record should be made complete. Also to forward their monthly reports not later than the 5th, so that the REVIEW can be published at an earlier date. Original entries should be made in the book (Form 1) furnished by the service, and not on loose slips of paper. This will avoid errors in transcribing. Those not furnished with addressed envelopes should address all communications to the Pennsylvania State Weather Service, Philadelphia, Pa.

Percentage of local verifications of weather and temperature signals as reported by displaymen for April, 1889:

Weather, 82 per cent.
Temperature, 86 per cent.

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Displayman.	*Station.*
U. S. Signal Office,	Philadelphia.
Wanamaker & Brown,	"
Pennsylvania Railroad Company,	"
Continental Brewing Company,	"
Samuel Simpson,	"
B. T. Babbitt,	"
Western Meat Company,	"
Neptune Laundry,	"
Chester Oil Company,	Chester.
C. W. Burkhart,	Shoemakerville.
A. N. Lindenmuth,	Allentown.
C. B. Whitehead,	Bradford.
Capt. Geo. R. Guss,	West Chester.
Werner & Son,	Emporium.
C. E. Lenhart,	Latrobe.
Thomas F. Sloan,	McConnellsburg.
J. H. Fulmer,	Muncy.
W. T. Butz,	New Castle.
S. W. Morrison,	Oxford.
Capt. A. Goldsmith,	Quakertown.
J. L. Morrison,	Sharon.
Wm. A. Engel,	Shenandoah.
Wm. Schrock,	Somerset.

Displayman.	*Station.*
Postmaster,	Meadville.
Frank Ross,	Oil City.
Lerch & Rice,	Bethlehem.
John W. Aitken,	Carbondale.
Signal Office,	Erie.
J. R. Raynsford,	Montrose.
E. P. Wilbur & Co.,	South Bethlehem.
Agricultural Experiment Station,	State College.
Signal Office,	Pittsburgh.
E. H. Baker,	Williamsport.
New Era,	Lancaster.
State Normal School,	Clarion.
Clarion Collegiate Institute,	Rimersburg.
E. S. Chase,	Eagles Mere.
Thiel College,	Greenville.
D. G. Hurley,	Altoona.
Armstrong & Brownell,	Smethport.
J. E. Forsythe,	Butler.
James H. Fones,	Tionesta.
Wister, Hacker & Savage,	Germantown.
W. J. Thompson & Co.,	Clifton Heights.
Steward M. Dreher,	Stroudsburg.
State Normal School,	Millersville.
E. C. Wagner,	Girardville.
Hartford P. Brown,	Rochester.
L. H. Grenewald,	York.
J. E. Pague,	Carlisle.
C. L. Peck,	Coudersport.
H. D. Miller,	Drifton.
Smith Curtis,	Beaver.
M. Tannehill,	Confluence.
S. C. Burkholder,	Pollock.
Robt. M. Graham,	Catawissa.
Henry F. Bitner,	Millersville.
A. J. Edelman,	Pottstown.
A. M. Wildman,	Langhorn.
N. E. Graham,	East Brady.
B. F. Gilmore,	Chambersburg.
Frank M. Morrow,	Altoona.
A. Simon's Sons,	Lock Haven.
E. W. McArthurs,	Meadville.
J. K. M. McGovern,	Lock No. 4.
Raftsman's Journal,	Clearfield.
W. S. Ravenscroft,	Hyndman.
R. C. Schmidt & Co.,	Belle Vernon.

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"Any resident of North America who shall determine by experiment whether all rays of light, and other physical rays, are or are not transmitted with the same velocity."

The following conditions have been established for the award of this Premium:

1. Any resident of North America, or of the West India Islands, may be a competitor for the Premium; the southern boundary of Mexico being considered as the southern limit of North America.

2. Each competitor must transmit to the Secretary of the FRANKLIN INSTITUTE a memoir, describing in detail the apparatus, the mode of experimenting, and the results; and all memoirs received by him before the first day of January, one thousand eight hundred and ninety will, as soon as possible after this date, be transmitted to the Committee of Judges.

3. The Board of Managers of the FRANKLIN INSTITUTE shall, before the first day of January, one thousand eight hundred and ninety, select three citizens of the United States of competent scientific ability, to whom the memoir shall be referred; and the said Judges shall examine the memoirs and report to the FRANKLIN INSTITUTE whether, in their opinion, and, if so, which of their memoirs is worthy of the Premium. And, on their report, the FRANKLIN INSTITUTE shall decide whether the Premium shall be awarded as recommended by the Judges.

4. Every memoir shall be anonymous, but shall contain some motto or sign by which it can be recognized and designated, and shall be accompanied by a sealed envelope, endorsed on the outside with some motto or sign, and containing the name and address of the author of the memoir. It shall be the duty of the Secretary of the FRANKLIN INSTITUTE to keep these envelopes securely and unopened until the Judges shall have finished their examination; when should the Judges be of opinion that any one of the memoirs is worthy of the premium, the corresponding envelope shall be opened, and the name of the author communicated to the INSTITUTE.

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6. The memoirs presented for the Premium shall become the property of the FRANKLIN INSTITUTE, and shall be published as it may direct.

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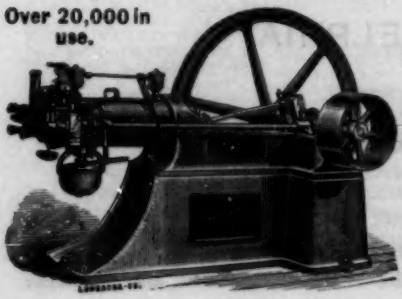

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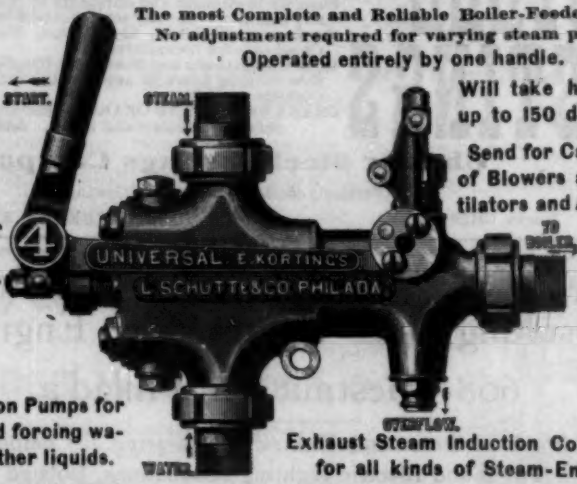

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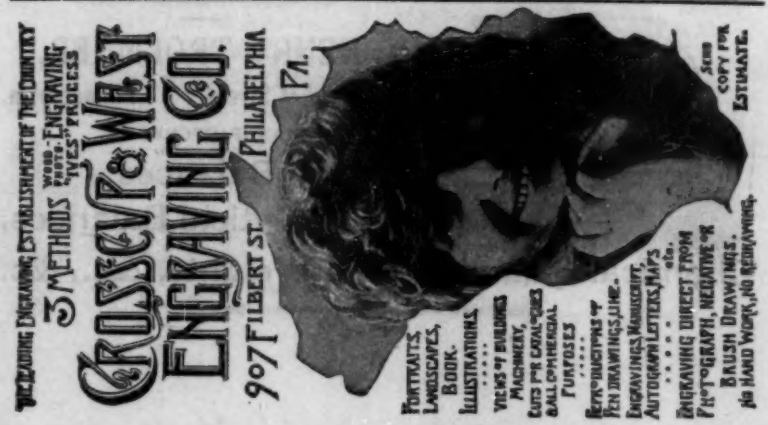
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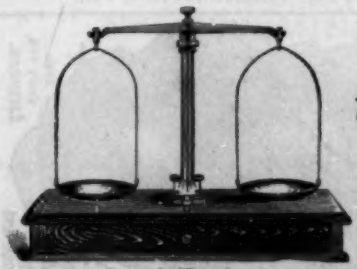

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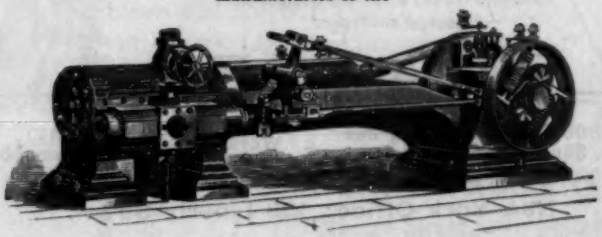

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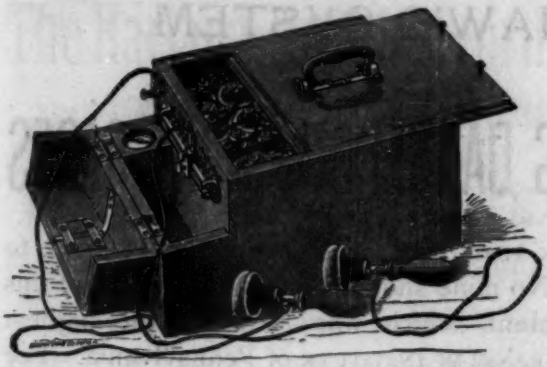

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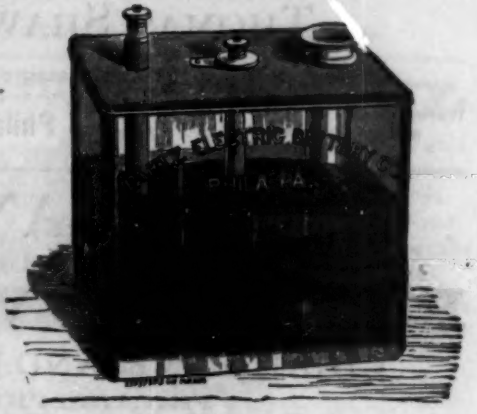

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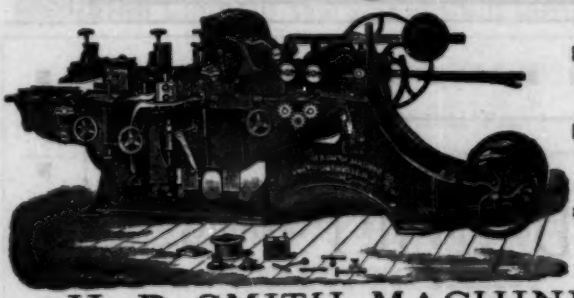

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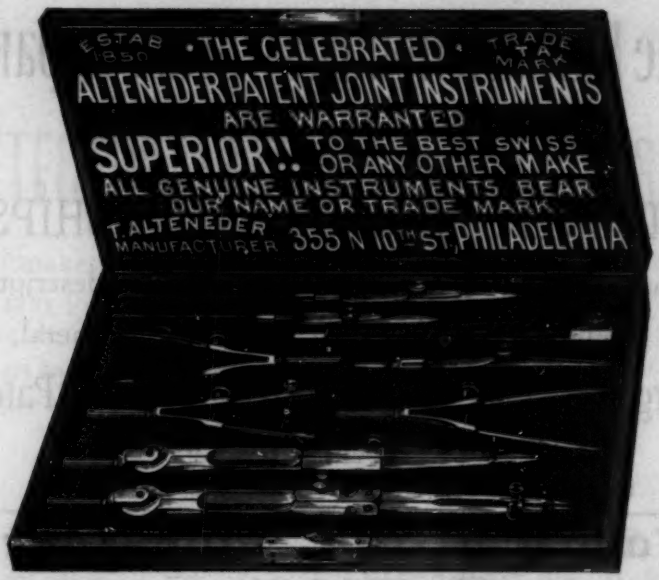
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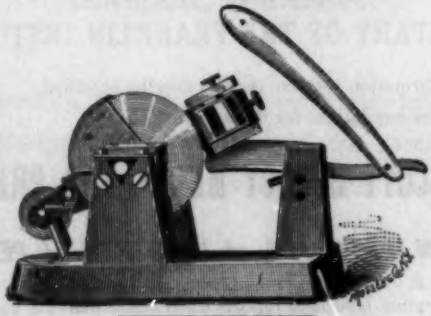

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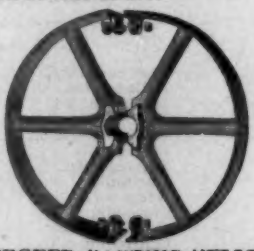

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